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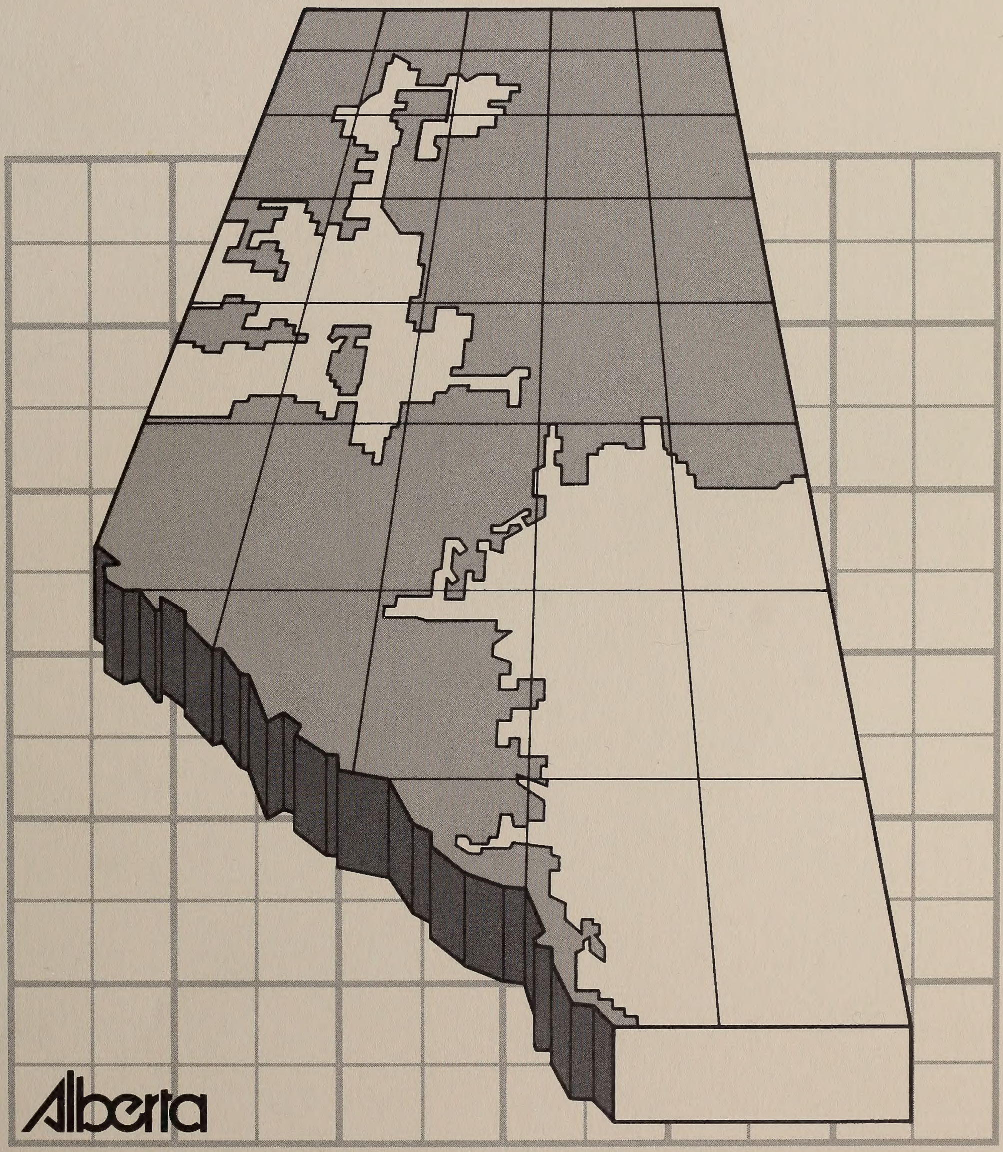
Agricultural Land Base Study

Agricultural Inventory



Alberta

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AGRICULTURAL LAND BASE STUDY:
DEVELOPMENT OPPORTUNITIES FOR THE FUTURE

AGRICULTURAL INVENTORY

Alberta
Agriculture
Environment
Forestry, Lands and Wildlife
Municipal Affairs
Transportation

Edmonton
January, 1988

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AGRICULTURAL INVENTORY

FOREWARD

The Agricultural Land Base Study (ALBS) is an interdepartmental study undertaken by Alberta Agriculture, Environment, Forestry, Lands and Wildlife, Municipal Affairs, and Transportation. The study is designed as a long-range planning tool for future agricultural development and is not an implementation study. The Agricultural Inventory's goal is to estimate provincial and regional increases in production resulting from ten agricultural development opportunities.

Increased agricultural production is just one of the criteria by which the ALB study has evaluated each opportunity. Any significant initiative to more effectively manage Alberta's land and water resources for agriculture needs to consider a number of approaches and their impacts, physical and economic, on other resource uses. The Agricultural Inventory Report represents one component of the Agricultural Land Base Study. Conclusions can only be drawn in collective consideration of each of the following background reports:

- Government Programs Promoting Agricultural Expansion and Intensification
- Analysis of Impacts on Other Resources
- Economic and Financial Analysis: Direct Benefits and Costs
- Economic Impact Analysis
- ALBS: Summary Report

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AGRICULTURAL INVENTORY

EXECUTIVE SUMMARY

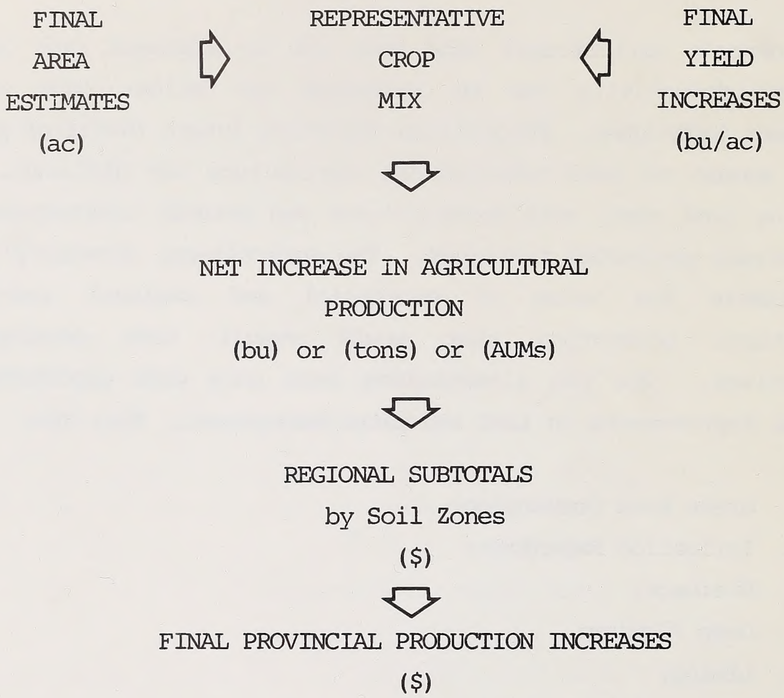
Alberta's agricultural land base can be expanded into new areas, and its productivity can be increased by various land and water management techniques. Projections regarding future levels of production or the amount of land required for agriculture are difficult to make. Competing land uses, soil deterioration and natural limitations all act to constrain projected increases. The Agricultural Inventory's goal is to estimate the value of provincial and regional increases in agricultural production that would result from developing ten alternatives. The ten alternatives deal only with opportunities for physical improvements in land and water management. They are:

1. Green Area Conversion;
2. Irrigation Expansion;
3. Drainage;
4. Deep Plowing;
5. Liming;
6. Summerfallow Reduction;
7. Range Improvement;
8. Prairie Range Conversion;
9. Woodland Conversion;
10. Saline Soil Reclamation.

The Inventory's three primary tasks were to estimate the area, yield and crop mix for each of the development alternatives. Initial estimates were made on the basis of published statistical data. Final or refined estimates were made by various resource specialists and took into account agricultural capability, current agricultural use, regional variations in productivity and current management practices. The on-farm economic and financial analysis, impacts on other resource uses and societal benefit cost analysis are considered in separate Agricultural

Land Base Study background reports. The following schematic diagram outlines the process by which increases in agricultural production are estimated for each of the ten development alternatives.

Figure 1


FINAL AREA ESTIMATES (ac)
REPRESENTATIVE CROP MIX
FINAL YIELD INCREASES (bu/ac)
NET INCREASE IN AGRICULTURAL PRODUCTION
(bu) or (tons) or (AUMs)
REGIONAL SUBTOTALS
by Soil Zones
($)
FINAL PROVINCIAL PRODUCTION INCREASES
($)

Brief descriptive summaries for each of the development alternatives examined are included in the following sections:

1. Green Area Conversion

The provincial Green Area, which consists of public lands withdrawn from settlement, covers approximately 51 percent of Alberta's total area. These lands are primarily managed for forest production, watershed protection, recreation and many other uses. If suitable, public lands may be made available for agricultural disposition. There are approximately 10.8 million acres of potentially arable lands, (CLI Class 1-4) located mainly in the northwest portion of the Green Area. Public Lands Division indicates that where no other resource concerns exist, approximately 15 percent of the lands are not posted due to physical landscape limitations. Accordingly, it is estimated that 9.2 million acres could be brought into crop production. Production increases were initially based on average yields established for the Peace River area. The average yields were subsequently reduced in consideration of the higher concentration of CLI Class 4 lands in the Green Area. The estimated value of potential production increases resulting from full implementation is $762 million.

2. Irrigation Expansion

Climate is one of the most important factors influencing the range, yields and quality of crops grown. A wider range of crops with a higher value may be grown with irrigation than under dryland conditions. Productivity in the semi-arid regions of southern Alberta can be increased from 60 percent to 200 percent by irrigation. Approximately 8.9 million acres of land have fair to good physical potential for irrigation. Water availability within this region is the major factor limiting irrigation expansion. The maximum acreage which can be irrigated with existing water supplies, assuming a 50 percent allocation of water to Saskatchewan as part of the existing inter-provincial apportionment agreement is 2.3 million acres. Approximately 1.2 million acres are currently irrigated, leaving a balance of 1.1 million acres for irrigation expansion. The estimated value of potential production increases resulting from full implementation totalled $306 million.

3. Drainage

Much of the agricultural land base in Central and Northern Alberta is affected by excess moisture. In some areas of central Alberta, potholes and sloughs are the most common type of wetland, often associated with undulating of "knob and kettle" topography. In the northern portion of the Central region and in large areas of the Peace River region, organic soils form wetlands which may be classified as bogs (often consisting of accumulations of moss and usually acidic in nature) or fens (typically formed from accumulations of sedge material). In some of the level areas of the Peace River region, where heavy soils limit the rate of water percolation into the soil, large areas of "sheetwater" or temporarily flooded cultivated land can be found. Drainage of agricultural land can involve a combination of several techniques or practices. The most common on-farm approachs are the construction of surface ditches and subsurface tilling.

Based on estimates provided from the report Drainage Potential in Alberta - An Integrated Study, approximately 2.1 million acres of non-permanent wetlands were determined to be suitable for drainage. This represents 22 percent of the total wetlands identified in the central and northern regions of the White Area. The gross annual value of production resulting from full implementation totals $241 million.

4. Deep Plowing

Solonetzic soils are characterized by an impermeable sodium hardpan layer which severely restricts root and water penetration vital to plant growth. Solonetzic soils are usually less fertile, and their productivity depends largely on the depth of overlying topsoil. The productivity of some solonetzic soils can be increased by deep plowing. Deep plowing physically breaks up the hardpan layer, mixes the soil by diluting the sodium with calcium from lower levels and improves the soil structure. While there are about 10.7 million acres of solonetzic soils in Alberta, less than 2.2 million acres in central Alberta can be made more productive through deep plowing. Yield increases vary both from site to site and from year to year following deep plowing. Where deep plowing is successful, average regional yields should be achieved. The estimated value of potential production increases resulting from full implementation is $83 million.

5. Liming

In Alberta, soils with a pH level less than or equal to 6.0 are considered acidic. Soil pH affects the physical, chemical and biological properties of soils, which in turn, affect nutrient availability and reduce crop production. Crops vary greatly in their tolerance to acidity. To overcome the problems of soil acidity, acid tolerant crops can be grown or lime can be applied to neutralize the soil. Following treatment, productivity will return to regional average yields. erosion and loss of organic matter. These problems can be ameliorated by

Depending upon cropping practices, fertilizer rates and soil type, lime must be reapplied every 5 to 10 years to maintain average crop yields. It is estimated that more than 2.6 million acres of acid soils in Alberta would benefit from liming. The estimated value of potential production increases resulting from full implementation is $50 million.

6. Summerfallow Reduction

Summerfallow is defined as cultivated land allowed to lie idle during the growing season. Perceived advantages of summerfallowing include increased soil moisture, weed control, and nutrient availability. Summerfallowing, however, can result in problems such as salinity, reducing summerfallow acreages. While the practice of summerfallowing may never be totally eliminated, improved stubble seeding, snow trapping, and improved weed control all contribute to reduced summerfallow acreages. In 1981, approximately 5.4 million acres were summerfallowed in Alberta. The Canada Grains Council estimates that provincial summerfallow acreage could be reduced by about 25 percent by 1990. This would result in an additional 1.37 million acres being made available for crop production with little or no reduction in average yields. The estimated value of potential production increases resulting from full implementation is $137 million.

7. Range Improvement

The rangelands of Alberta play a major role in maintaining beef cow herds and producing feeder animals. For the purposes of this study, range improvement is defined as breaking and seeding prairie range to tame pasture in southern Alberta and clearing, breaking, seeding, fertilizing and fencing woodland range to tame pasture in central and northern Alberta. Rangeland improvement offers cattle producers an opportunity to increase production without expanding their grazing land base. There are approximately 11 million acres of CLI Class 5 lands available for range improvement in the White Area of Alberta. In Considering that some lands are already improved and that there are other physical limitations, it is estimated that approximately 13 percent or 1.41 million acres may be suitable for range improvement. The estimated value of potential production increases resulting from full implementation is $50 million.

8. Prairie Range Conversion

Rangeland accounts for a significant portion of southern Alberta's agricultural land base. A portion of the CLI 1-4 land base currently used as pasture could produce field crops. Rangeland conversion is defined as breaking and seeding prairie range for the production of annual field crops. It is estimated that approximately 3.53 million acres of CLI class 1-4 lands in southern Alberta have a potential for range conversion. The estimated value (in consideration of the lost grazing resource) of potential production increases resulting from full implementation is $191 million.

9. Woodland Conversion

A large portion of the White Area in north and north-central Alberta is still covered by forest and bush. Some of these CLI 1-4 woodland areas could produce field crops. Woodland conversion is defined as clearing, breaking and seeding woodland areas to annual field crops. It is estimated that approximately 7.07 million acres of CLI Class 1-4 lands have a potential for woodland conversion. The estimated value (in consideration of the lost grazing resource) of potential production increases resulting from full implementation is $568 million.

10. Saline Soil Reclamation

Saline soils are scattered in patchy areas throughout the province but are most commonly found in south and southeast Alberta. Historically, saline seeps occur naturally as a result of processes which cause soluble salts to occur at or near the surface of the soil. Salinization, however, may also be the result of man's activities. Summerfallowing, water and snow accumulation, irrigation, deforestation and overgrazing are all responsible for increasing development of saline seeps. It has been estimated that approximately 2.47 million acres of salt-affected land could be reclaimed through proper management: 2.22 and 0.25 million acres for dryland and irrigated salinity respectively. Soil salinity not only reduces or eliminates crop production but may also isolate good parcels of land. The productivity of most crops varies according to the severity of salinization. It is assumed, for this study, that under correct management practices, yields can be restored to the regional average. The estimated value of potential production increases from reclamation of Salinized Lands is $112 million. The estimated value for reclamation of irrigated and dryland salinity resulting from full implementation is $59 and $53 million respectively.

Summary

The Agricultural Inventory was undertaken to estimate the location, area, and increases in agricultural production resulting from the full implementation of ten development alternatives. Area and production estimates are presented as millions of acres and dollars respectively. The Inventory provides a comprehensive comparative analysis of each development alternative's potential for increasing agricultural production in Alberta.

A provincial summary of the Inventory's results are presented in Table 1, Figures 1 and 2. A total of 33 million acres were identified as being suitable for agricultural expansion or intensification. The total Inventory acreage represents an area equivalent to Alberta's currently improved land base of 30 million acres, as defined by the 1981 Census of Agriculture. Full implementation of the identified acreage would result in a total increase in agricultural production valued at $2.5 billion annually. The total Inventory production estimates represent a 65 percent increase in Alberta's 1984 Annual Farm Cash Receipts of $3.9 billion. The derived provincial average value of production per acre, resulting from full implementation of all ten development alternatives, was estimated to equal $75. The total value of production calculations represent a gross dollar estimate based solely on the value of agricultural production realized from full implementation. These calculations do not consider economic effeciencies nor the relative costs of implementation to the farmer or society. These analyses were undertaken as seperate Agricultural Land Base Study technical reports.

Individually, the ten development alternatives represent significant opportunities for increasing agricultural production. Each alternative affects more than 1 million acres and generates a corresponding increase in production valued in excess of $50 million annually. However, individual development alternatives exhibit a wide degree of variability in both acreages available for development and their corresponding

potential increases in production. Acreage estimates range from a low of 1.1 million acres for Irrigation Expansion to a high of 9.2 million acres for Green Area Conversion. The average acreage estimate is approximately 3.3 million acres. Production estimates range from a low of $50 million for Liming and Range Improvement (Prairie and Woodland) to a high of $762 million annually for Green Area Conversion. The average production estimates are valued at $250 million annually. The value of production per acre estimates also show considerable variability; ranging from a low of less than $20 per acre for Prairie Range Improvement and Liming to a high of more than $200 per acre for the Irrigated-Saline Soil Reclamation and Irrigation Expansion.

Table 1

INCREASES IN ANNUAL AGRICULTURAL PRODUCTION BY DEVELOPMENT ALTERNATIVES*

DEVELOPMENT ALTERNATIVES	TOTAL VALUE OF PRODUCTION ($ MILLION)	POTENTIAL AREA (MILLION ACRES)	VALUE OF PRODUCTION ($/ACRE)
1. Green Area Conversion	762	9.20	82.83
2. Irrigation Expansion	306	1.14	268.42
3. Drainage	241	2.12	113.68
4. Deep Plowing	83	2.22	37.39
5. Liming	50	2.61	19.16
6. Summerfallow Reduction	137	1.37	100.00
7. Range Improvement			
-Prairie	18	1.04	17.31
-Woodland	31	0.37	83.78
8. Prairie Range Conversion	191	3.53	54.11
9. Woodland Conversion	568	7.07	80.34
10. Saline Soil Reclamation			
-Dryland	59	2.22	26.44
-Irrigated	53	0.25	212.40
PROVINCIAL TOTALS	2499	33.14	75.41

*Area overlaps and double counting are avoided wherever possible.

Regional analyses are used to illustrate the distribution of development opportunities across the province and to identify differences in the distribution of acreages available or the corresponding production potential with full implementation. The original Inventory data were generated on the basis of soil zones. Soil zone subtotals may

Figure 1 Provincial Summary Total Value of Production

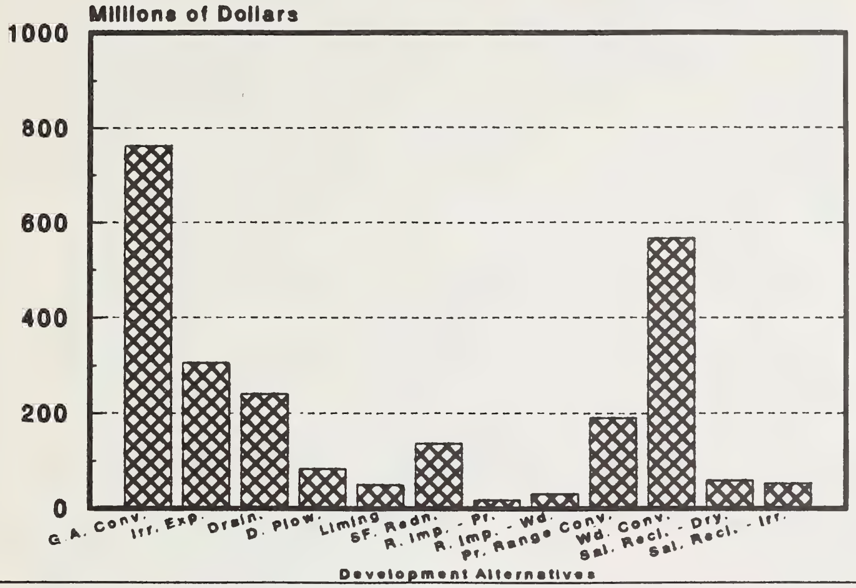
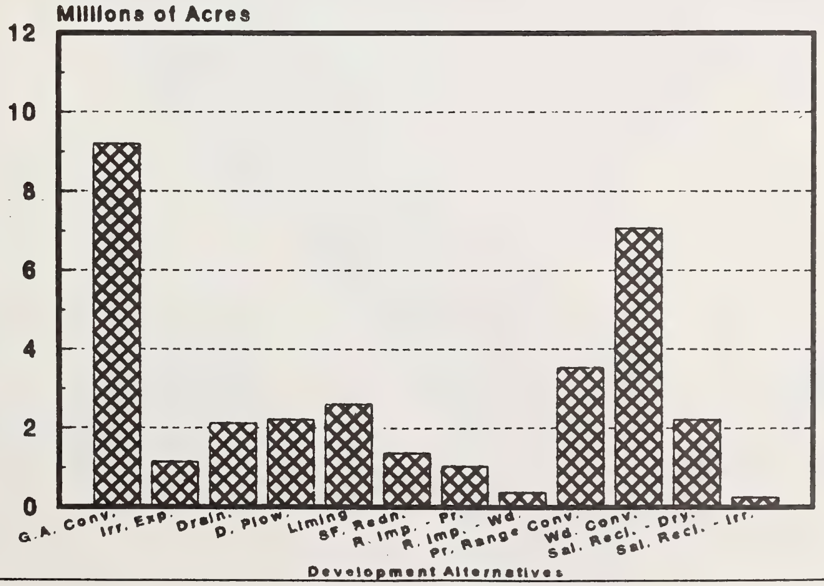
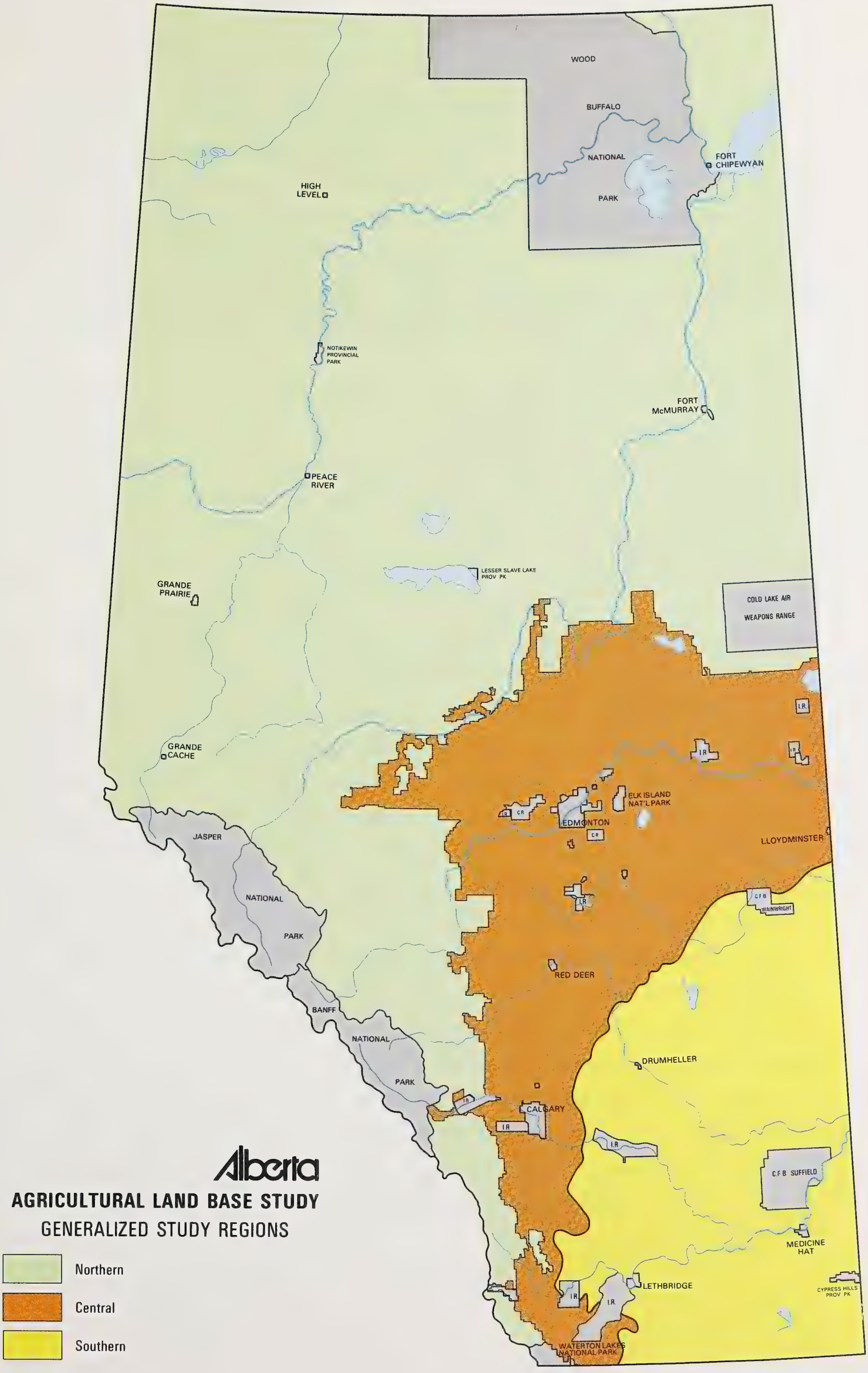


Figure 2 Provincial Summary Total Area Distribution





Alberta

AGRICULTURAL LAND BASE STUDY

GENERALIZED STUDY REGIONS

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA FORESTRY, LANDS AND WILDLIFE, 1986.

be aggregated in different combinations to facilitate the examination of data from a regional perspective. The following soil zones were aggregated to define the three regions used in the Agricultural Land Base Study: Northern (Luvisols-Green Area and Luvisols-Peace River soil zones); Central (Luvisols-Central and Black soil zones); and Southern (Dark Brown and Brown soil zones). The Generalized Study Regions Map illustrates the three broad regions prepared for this analysis.

In total, the acreages available for development and the corresponding production potentials are uniformly distributed among the Northern, Central and Southern regions (Figures 3, 4). The Northern region accounts for approximately 40 percent, 14 million acres and $1065 million annually,of the total provincial development potential. potential. The remaining development potential is equally distributed among the Central (30 percent), 10 million acres and $740 million annually, and Southern (30 percent), 9 million acres and $690 million annually, regions. The average value of production per acre remains constant at $75 for all three regions. However, the number and types of development alternatives contributing to the regional potential vary significantly. Only two development alternatives, Green Area Conversion and Woodland Conversion, contribute significantly to the Northern region's development potential. In the Central region several smaller alternatives contribute to the regions development potential: Woodland Conversion, Drainage, Deep Plowing and Range Conversion. The Southern region also has several significant contributing development opportunities: Irrigation Expansion, Range Conversion, Summerfallow Reduction and Saline Soil Reclamation. In summary, the regional agricultural development potential is greatest in Northern Alberta; however fewer significant alternatives are available to promote development within this region. In contrast, Central and Southern Alberta have a somewhat lower total development potential, but there are a greater number of significant opportunities contributing to this potential.

Figure 3 Generalized Study Regions
Total Value of Production
(Millions of Dollars)

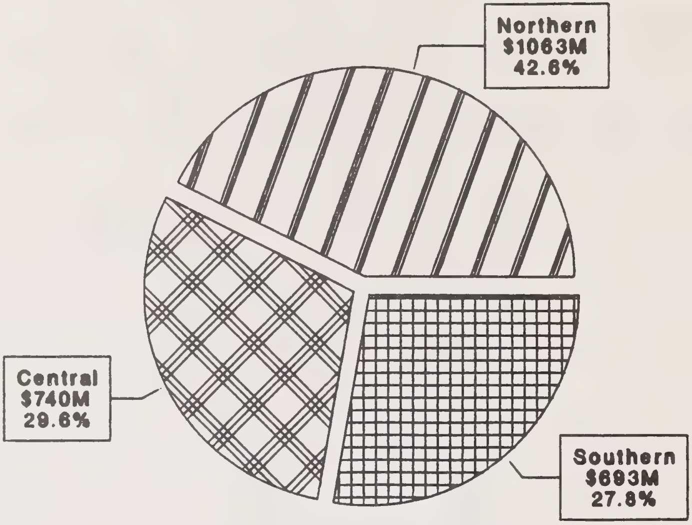
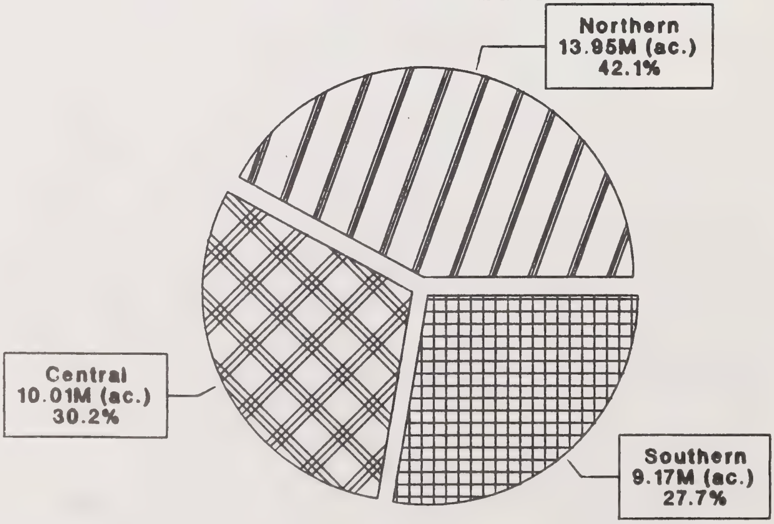


Figure 4 Generalized Study Regions
Total Area Distribution
(Millions of Acres)



The total area examined in the Agricultural Inventory is roughly equal in size to Alberta's currently improved land base. However, the resulting production increases from full implementation only represent two-thirds increase in 1984 Annual Farm Cash Receipts. The proportiontely lower increase in the value of agricultural production emphasizes a key difference between those lands identified for future agricultural development and those lands currently in production. More than 100 years of settlement in Alberta has resulted in extensive development of the province's higher capability agricultural lands. Consequently the productivity of many of the development alternatives examined in the Agricultural Land Base Study are restricted by lower natural soil fertility. It is estimated that 90 percent of the lands identified for agricultural expansion are rated as lower capability CLI class 4 lands. Intensification opportunities, with the exception of the Irrigation related alternatives, result in smaller incremental increases in production on lands currently devoted to agricultural production.

The Agricultural Land Base Study is designed as a long-range tool for planning future agricultural development in Alberta and is not an implementation study. The results of this report indicate that Alberta's land and water resources should not restrict the future growth of the agricultural industry. It is also significant to note that Alberta has a broad range of development alternatives available. All ten development alternatives examined represent significant opportunities for increasing agricultural production across the province. The magnitude of these opportunities indicates a resource of national significance. Alberta is recognized as having one of the last large blocks of undeveloped lands available for future agricultural expansion in Canada.

Increased agricultural production is just one of the criteria by which the Agricultural Land Base Study has evaluated each alternative. Any significant initiative to more effectively manage Alberta's resources for agricultural production needs to consider a number of approaches and their impacts on other resource uses. The Agricultural Inventory represents one component of the Agricultural Land Base Study. Final conclusions can only be drawn in collective consideration of each of the remaining five background reports.

TABLE OF CONTENTS

Foreword.. iii

Executive Summary.............................. v

List of Illustrations.......................... xxi

List of Tables................................. xxiii

1. INTRODUCTION.................................. 1

2. GUIDELINES 5

3. METHODOLOGY.................................. 9

4. RESULTS

4.1 Green Area Conversion...................... 21
4.2 Irrigation Expansion....................... 27
4.3 Drainage................................... 37
4.4 Deep Plowing............................... 47
4.5 Liming 55
4.6 Summerfallow Reduction..................... 63
4.7 Range Improvement.......................... 71
4.8 Prairie Range Conversion................... 79
4.9 Woodland Conversion;....................... 87
4.10 Saline Soil Reclamation 95

5. SUMMARY...................................... 107

APPENDIX.. 123

GLOSSARY.. 151

REFERENCES...................................... 161

LIST OF ILLUSTRATIONS

Page

2.1 Study Area.. 7

3.1 ALBS Soil Zones..................................... 13

3.2 CLI Agricultural Capability - White Area.................. 17

3.3 Agricultural Land Use................................. 19

4.1.1 Potentially Arable Land in the Green Area................. 23

4.2.1 Land Irrigability Potential............................. 29

4.2.2 Private Irrigation Projects 31

4.3.1 Wetlands and Drainage Potential 39

4.4.1 Solonetzic Soils That Respond to Deep Plowing............. 49

4.5.1 Acid Soil Areas in Alberta............................. 57

4.6.1 Provincial Summerfallow 1971-1982 Trends.................. 64

4.6.2 Percentage of Cultivated Area in Summerfallow 67

4.7.1 Percentage of Total CLI Class 5 Lands 73
Available for Range Improvement

4.8.1 Prairie Range Conversion Potential........................ 81

4.9.1 Woodland Conversion Potential........................... 89

4.10.1 Dryland Areas Containing Saline Soils..................... 97

4.10.2 Irrigated Land Containing Saline Soils - Irrigated........ 99

5.1 Provincial Summary, Total Value of Production 111

5.2 Provincial Summary, Total Area Distribution 112

5.3 Generalized Study Regions 115

5.4 Generalized Study Regions, Total Value of Production 114

5.5 Generalized Study Regions, Total Area Distribution 114

5.6 Northern Region, Total Value of Production 118

5.7 Central Region, Total Value of Production 118

5.8 Southern Region, Total Value of Production 118

5.9 Northern Region, Total Area Distribution 118

5.10 Central Region, Total Area Distribution 118

5.11 Southern Region, Total Area Distribution 118

LIST OF TABLES

Table Page

3.1 Representative Crop Mix Data........................ 10

3.2 Benchmark Yields for the Major Crops.................. 12

3.3 Primary Agricultural Use - Prior to Development....... 15

4.1.1 CLI Soil Capability for Agriculture................... 22

4.1.2 Average Gray Soil Zone Crop Yields: Peace River and Green Area....................................... 25

4.1.3 Increased Agricultural Production: Green Area Conversion 26

4.2.1 Serviced Irrigated Acreage 1983........................ 33

4.2.2 Irrigation Expansion Area Estimates.................... 34

4.2.3 Estimated Average Irrigated Crop Yields................ 35

4.2.4 Irrigation Expansion: Estimated Net Production Increases... 36

4.3.1 Drainage, Summary of Wetlands Inventory by Drainage Basin 41

4.3.2 Drainage, Non-permanent Wetlands by Soil Zones 42

4.3.3 Benchmark Yields for the Major Crops 43

4.3.4 Drainage, Gross Annual Value of Production by Crops 44

4.3.5 Drainage, Gross Annual Value of Production by Soil Zones 45

4.4.1 Acreage Available for Deep Plowing 48

4.4.2 Increase in Crop Production After Deep Plowing 52

4.4.3 Provincial and Regional Increase in Production from Deep Plowing 53

4.5.1 Acid Soil Acreage on Cultivated Lands by Soil Zones.... 59

4.5.2 Crop Production Increase after Liming 61

4.5.3 Increases in Production 62

4.6.1 Acreage Available for Crop Production After Summerfallow Reduction.. 65

4.6.2 Benchmark Crop Yields for the Major Dryland Crops by Soil Zone.. 69

4.6.3 Increase in Production - Reduction of Summerfallow...... 70

4.7.1 Acreage Available for Range Improvement................. 72

4.7.2 Average Carrying Capacities on Prairie Range............ 75

4.7.3 Average Carrying Capacities on Woodland Range........... 76

4.7.4 Increase in Production - Range Improvement.............. 78

4.8.1 Prairie Range Conversion Acreage Estimates.............. 80

4.8.2 Increase in Crop Production After Conversion 83

4.8.3 Increase in Production - Prairie Range Conversion....... 84

4.8.4 Increase in Value of Production - Prairie Range Conversion.. 85

4.9.1 Woodland Conversion Acreage Estimates................... 88

4.9.2 Increase in Crop Production After Woodland Conversion .. 91

4.9.3 Increase in Production - Woodland Conversion........... 92

4.9.4 Increase in Value of Production - Woodland Conversion.. 93

4.10.1 Acreage of Saline Soils in Alberta..................... 95

4.10.2 Regional Location or Acreage of Dryland Saline Soils in Alberta... 101

4.10.3 Regional Location or Acreage of Currently Irrigated Saline Soils in Alberta........................ 101

4.10.4 Increase in Crop Production on Dryland Areas After Reclamation... 102

4.10.5 Increase in Crop Production on Currently Irrigated Areas After Reclamation................................... 103

4.10.6 Increase in Production: Dryland Saline Soils 104

4.10.7 Increase in Production: Irrigated Saline Soils 105

5.1 Increases in Annual Agricultural Production by Development Alternatives 108

1. INTRODUCTION

Alberta's agricultural land base can be expanded into new areas, and its productivity can be increased by various land and water management techniques. Although numerous studies have suggested different approaches to expand agricultural production, these studies have focused on one approach, considered only a portion of the province, lacked comprehensive information, or have been relatively unconcerned with the effect that one approach may have upon other resource uses. Any significant initiative to more effectively manage Alberta's resources for agricultural production needs to consider a number of approaches and their impacts on other resource uses. The need for a more comprehensive policy on public and private agricultural resource development has led to the Agricultural Land Base Study (ALBS). The principal objectives of the A.L.B. Study are:

1. to identify the natural resource management options available for the expansion and intensification of Alberta's agricultural land base;

2. to identify the geographic distribution and the maximum potential increase in agricultural production achievable through the application of the management options;

3. to assess the relative economics of the management options;

4. to evaluate the impact of such management options on other resource uses; and

5. to identify existing government programs that promote the application of the management options.

Alberta's agricultural land base, yields and crop production have all increased since the province was first settled. Cultivated lands have increased by about one percent annually for the past 25 years, whereas productivity has increased by about 70 percent during the same period. Improved farm production technology and increased mechanization now allow a single farmer to farm more acres. The amalgamation of smaller farms and expansion onto new lands have also resulted in larger farms. In 1931, Alberta's farm population was 375 000 or 51 percent of the total provincial population, compared with 195 000 or nine percent of the 1981 total. Agricultural growth is continuing, and it is likely that additional lands will be required for both crops and livestock.

Extensive areas of land are suitable for agriculture in Alberta. The agricultural land base expanded from 400 000 acres in 1905 to 29.3 million by 1921 and 50 million acres by 1981. One third of Alberta's total land area is now devoted to agricultural production. Of the 50 million acres of farmland, approximately 30 million are improved and 20 million unimproved. Improved lands are primarily used for the production of field crops. Unimproved lands are the basis for this province's beef cattle industry. On average, Alberta's primary agricultural industry is equally balanced between crop and livestock production (farm cash receipts). Alberta presently contributes 20 percent of Canada's total agricultural production and maintains the largest livestock inventory of any province.

Projections regarding either levels of production or the amount of land required for agriculture are difficult to make. Competing land uses, soil deterioration and natural limitations all act to constrain projected increases. Additional lands and improved land management will be required to accommodate future agricultural development. The second objective defines the Agricultural Inventory component of the Agricultural Land Base Study. The Agricultural Inventory's fundamental goal is to estimate provincial increases in agricultural production resulting from ten development alternatives. The development alternatives evaluated by the Agricultural Land Base Study are:

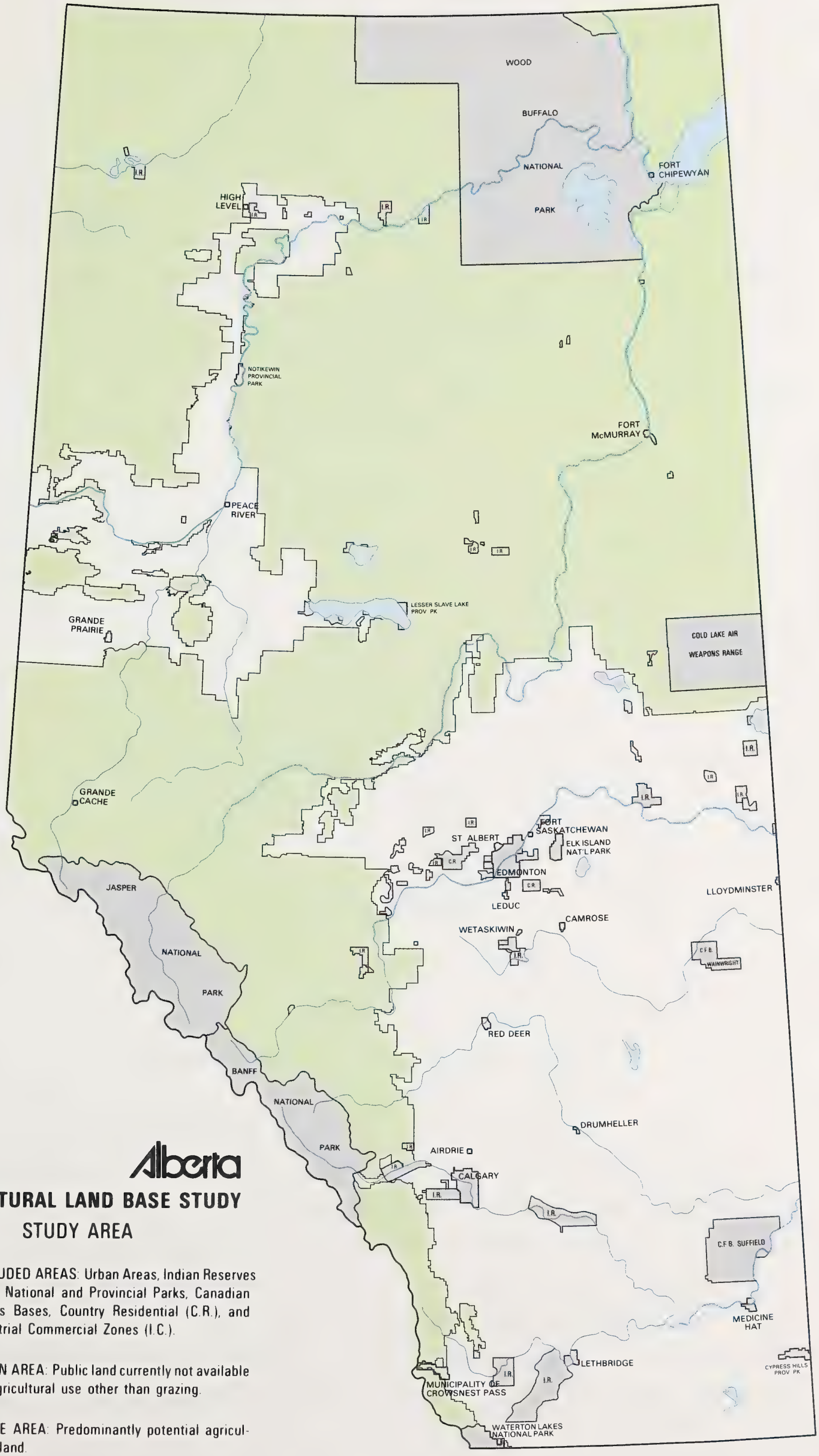
1. Green Area Conversion
2. Irrigation Expansion;
3. Drainage;
4. Deep Plowing;
5. Liming;
6. Summerfallow Reduction;
7. Range Improvement;
8. Prairie Range Conversion;
9. Woodland Conversion;
10. Saline Soil Reclamation.

More than one hundred years of settlement has resulted in extensive development of the province's higher capability agricultural lands. Consequently the productivity of many development alternatives examined in the Agricultural Land Base Study is restricted by low soil fertility, susceptibility to wind and water erosion, flooding, poor or imperfect drainage, soil moisture, salinity or acidity. The physical limits of agricultural production are not fixed but can be modified and extended through better management, research and technological innovations. Increases in agricultural production are estimated from expansion of the existing land base, removal of a physical limitation (improvement) or by the establishment of more intensive forms of land management. The Agricultural Inventory estimates the magnitudes of each development alternative's increased annual production.

2. GUIDELINES

The Inventory is confined to a review of the physical limitations of land and water resources. The potential for increasing agricultural production through the development of new technology and the application of other existing technologies, the review of agricultural research, technology transfer, use of fertilizers, farm management, the selection of higher value crops, and livestock enterprises are not within the scope of this study. The demand and price structure for agricultural commodities, while critical in determining the rate at which agricultural production will increase, are not considered a constraint for the purpose of this study. The following list of guidelines constitute the Inventory's working parameters.

Existing Resources	- Existing information is to be used to the greatest extent possible (given current fiscal and manpower limitations).
Scale	- Estimates to the nearest 0.1 million acres are consistent with the study's provincial perspective.
Area Included	- Land suitable for cultivation: CLI 1-4 Land suitable for improved grazing: CLI 5 - The White Area, and that portion of the Green Area that is classified for agriculture as CLI class 1-4 - Irrigation - climatic zones A1, A2, B and C for irrigation expansion.
Area Excluded	- Urban jurisdictions - Major rural residential, industrial, commercial or institutional zones - National or Provincial parks - Existing wildlife sanctuaries or ecological reserves - Military ranges; - Indian reserves and - CLI 6,7, organic and non-classified lands.



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AGRICULTURAL LAND BASE STUDY

STUDY AREA

▨ EXCLUDED AREAS: Urban Areas, Indian Reserves (I.R.), National and Provincial Parks, Canadian Forces Bases, Country Residential (C.R.), and Industrial Commercial Zones (I.C.).

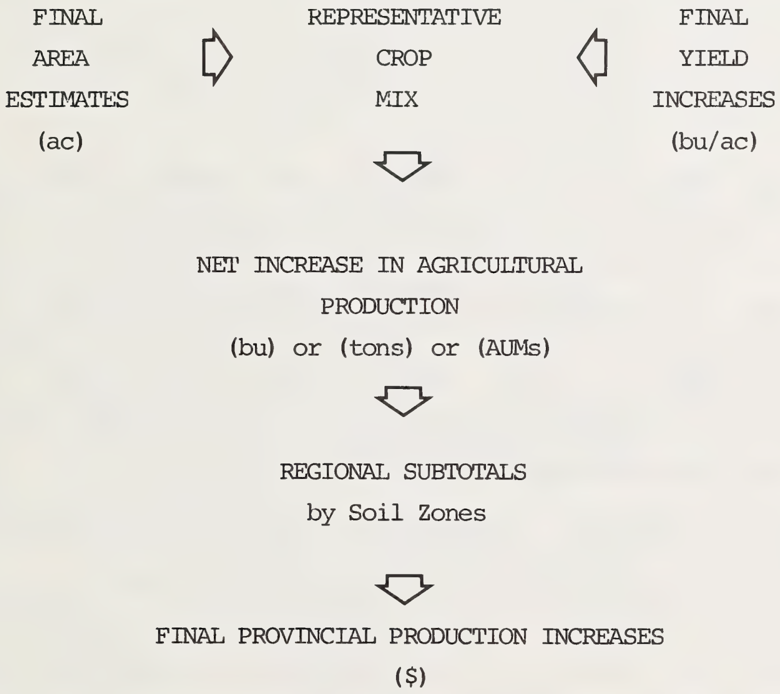
🟩 GREEN AREA: Public land currently not available for agricultural use other than grazing.

☐ WHITE AREA: Predominantly potential agricultural land.

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA ENERGY AND NATURAL RESOURCES, 1985.

3. METHODOLOGY

The Inventory's three primary tasks were to estimate the area, yield and crop mix for each of the development alternatives. Initial estimates were made on the basis of published statistical data. Final or refined estimates were made by various resource specialists and took into account agricultural capability, current agricultural use, regional variations and current management practices. The following schematic diagram outlines the process by which increases in agricultural production are quantified.


FINAL AREA ESTIMATES (ac)
REPRESENTATIVE CROP MIX
FINAL YIELD INCREASES (bu/ac)
NET INCREASE IN AGRICULTURAL PRODUCTION (bu) or (tons) or (AUMs)
REGIONAL SUBTOTALS by Soil Zones
FINAL PROVINCIAL PRODUCTION INCREASES ($)

The representative crop mix indicates the amount of land, as a percent of the total area, which is allocated to a specific crop type. Crop mix information provides the linkage between area and yield statistics. The representative crop mix data for each soil zone are recorded in Table 3.1. The five principal crops selected for the calculation of production increases represent approximately 97 percent of the province's seeded acreage. If area or crop yield refinements resulted in the deletion of any crops for which no data exist, a recalculation of the crop mix was undertaken. Maintaining 1981 summerfallow percentages throughout the analysis resulted in the estimation of a single year's increased production.

Table 3.1

REPRESENTATIVE CROP MIX DATA

(PERCENT OF TOTAL CULTIVATED LAND)

Soil Zone	Wheat	Oats	Barley	Canola	Hay	Other[1,2]	Summer Fallow[3]
Brown	42%	2%	6%	0.5%	7%	2%	41%
Dark Brown	37%	3%	17%	4%	7%	3%	29%
Black	20%	7%	35%	7%	16%	3%	13%
Gray (Central)	8%	10%	28%	3%	38%	2%	11%
Gray (Peace)	18%	4%	29%	12%	16%	1%	20%

Sources: 1981 Alberta Census of Agriculture
Agriculture Statistics Yearbook, 1982

1. Includes rye, flaxseed, forage seed, potatoes and other specialty crops.
2. Averaged into subsequent calculations.
3. Summerfallow maintained at 1981 levels thoughout analysis.

Although the statistical analysis applied to the whole province, it was initially prepared for each region by soil zones. Soil zones were selected to organize and present inventory results because they form a consistent basis for comparing regional variations in agricultural productivity. Influenced by soil fertility and climate, each soil zone reflects variations in natural productivity, growing season, rainfall patterns and organic matter. Soil zones also provide a regional perspective for the review of inventory results.

For the purposes of the Agricultural Land Base Study, the province was divided into six soil zones[1]: Brown, Dark Brown, Black, Gray - Central, Gray - Peace River, and Green Area (Figure 3.1). The natural productivity of these zones is not uniform. The Brown soil zone occurs in the semi-arid short-grass prairie region. Lack of moisture is a major limiting factor to crop growth and some of these soils are considered non-arable. Although less arid, lack of moisture also limits growth in the Dark Brown soil zone. The Black soil zone has more favourable moisture conditions and is generally high in organic matter and quite fertile. The Central, Peace River and Green Area Gray Soil Zone designations consider administrative, regional and productive differences. These Gray soil zones include three basic soil types, Dark Gray Chernozems, Dark Gray Luvisols and Gray Luvisols. One of the most serious limitations to the Gray soil zones is a shorter growing season.

Information derived from municipal-based sources were also aggregated into soil zones for statistical analysis (appendix 1). The Agricultural Statistics Yearbook was selected as the primary data source for establishing average crop yield benchmarks for each soil zone. Yearbook data, initiated in 1973, are based on an annual survey of producers, comparisons to information from preceding years and consultation with provincial crop analysts. Alberta Hail and Crop Insurance Corporation statistics isolate dryland crop yields. Their statistics were used for the Brown soil zone.

Average yields were recorded for Alberta's principal field crops: wheat, oats, barley, canola and tame hay. The 1979-83 average crop yields per soil zone are listed in Table 3.2. A five year average was believed to be representative of the most current farm management practices. Crop yield data specific to each development alternative are consistently referenced to these established benchmarks: (1) reduced yields to benchmark (e.g., Deep Plowing); (2) increased yields from benchmark (e.g., Irrigation Expansion); and (3) zero crop production to modified benchmark (e.g., Green Area Conversion).

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[1] Irrigation-climatic zones were used for the Irrigation Expansion development alternative.

Table 3.2

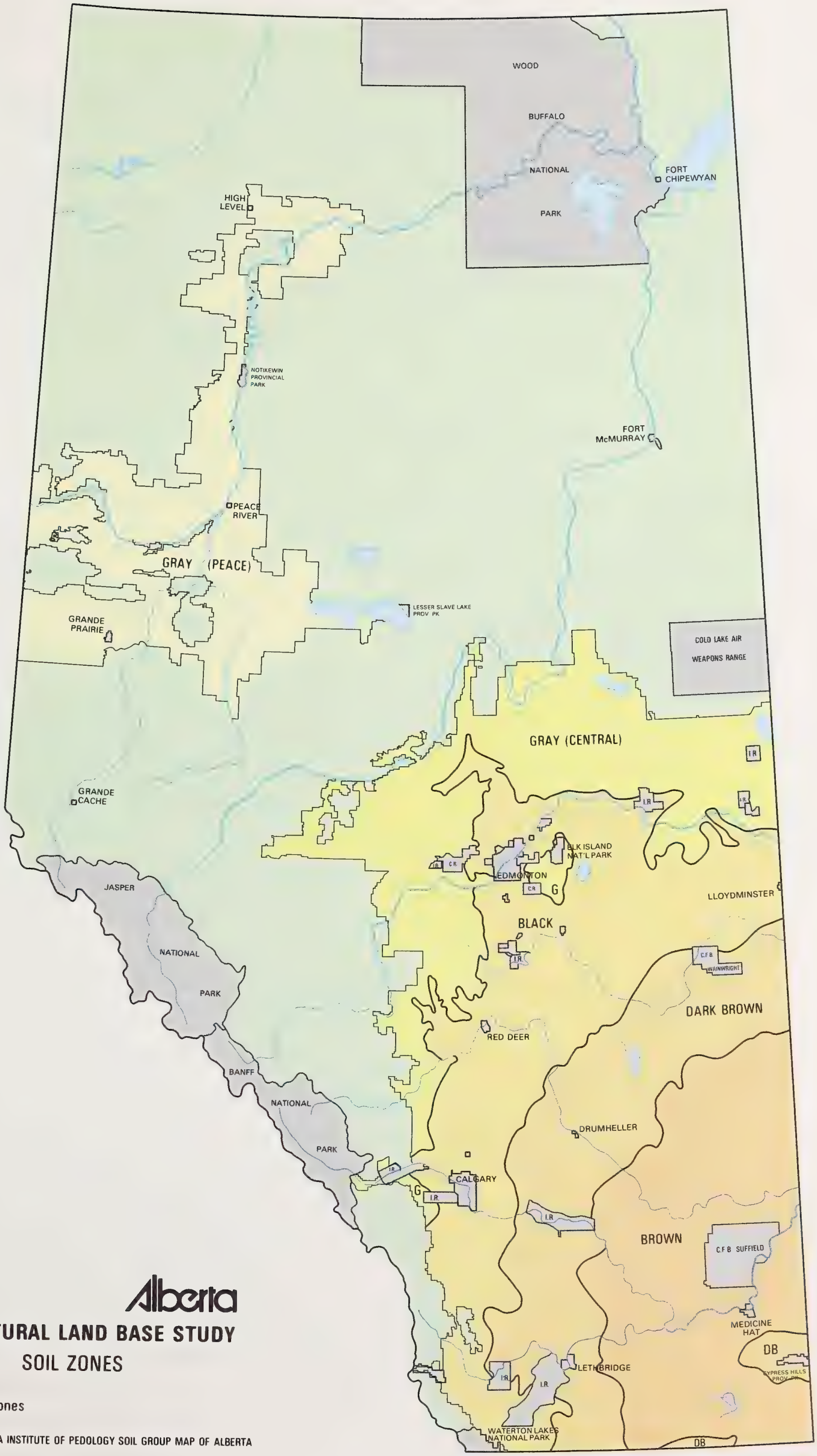
BENCHMARK YIELDS FOR THE MAJOR CROPS

Soil Zone	Benchmark Yields (Bu/acre) Wheat	Oats	Barley	Canola	Tame Hay (Tons/acre)	Benchmark Yields (as a percent of the Black Soil Zone) Wheat	Oats	Barley	Canola	Tame Hay
Black	35.3	63.0	48.8	22.5	1.5	100	100	100	100	100
Dark Brown	32.7	60.1	50.9	24.3	1.0	93	95	104	108	67
Brown	26.4	41.6*	44.1	18.0*	0.6	75	66	90	80	102
Gray (Central)	32.7	61.7	44.1	18.3	1.7	98	93	98	82	114
Gray (Peace)	29.9	55.8	38.6	16.5	1.6	85	89	79	74	107

Sources:

1. Agriculture Statistics Yearbook (1979-83).
2. Hail and Crop Insurance Corporation Data (1978-82) obtained from: Soil Inventory Data Base for Management and planning (SIDMAP).
3. Estimated Long-Term Average Hay Yields (Alberta Agriculture, 1985).

* Less than 500 cases recorded to establish yield.



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AGRICULTURAL LAND BASE STUDY

SOIL ZONES

——— Soil Zones

ADAPTED FROM ALBERTA INSTITUTE OF PEDOLOGY SOIL GROUP MAP OF ALBERTA

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA ENERGY AND NATURAL RESOURCES, 1985.

For each development alternative, assumptions were made as to current agricultural use prior to improvement. Prior use is generally assumed to represent the next best use before improvement and may apply to all or a percentage of the total area identified. Documentation of current agricultural use results in the estimation of incremental increases in agricultural production. Prior use assumptions for each alternative are indicated in Table 3.3.

Table 3.3

PRIMARY AGRICULTURAL USE - PRIOR TO DEVELOPMENT

	DEVELOPMENT ALTERNATIVES	ASSUMPTIONS
1.	Green Area Conversion	No Crop Production[1]
2.	Irrigation Expansion	Dryland Crop Production
3.	Drainage	No Crop Production
4.	Deep Plowing	Reduced Dryland Yields
5.	Liming	Reduced Dryland Yields
6.	Summerfallow Reduction	Fewer Seeded Acres
7.	Range Improvement	Unimproved Grazing
8.	Prairie Range Conversion	Unimproved Grazing
9.	Woodland Conversion	Unimproved Grazing
10.	Saline Soil Reclamation - Dryland	Reduced Dryland Yields
	- Irrigated	Reduced Irrigated Yields

1. Minimal unimproved grazing.

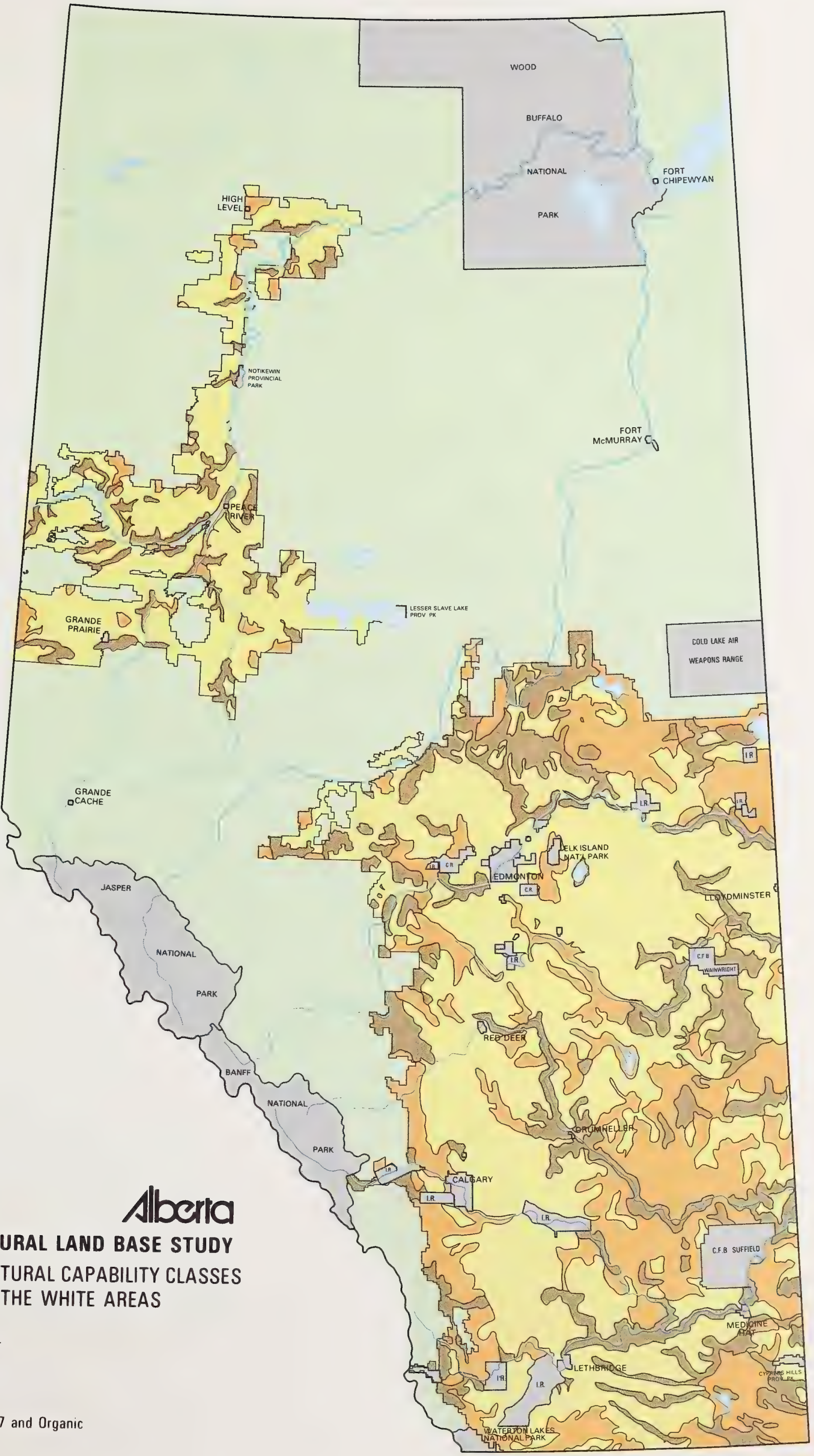
Diversity within each of the ten development alternatives resulted in the use of several different units of measurement: volume (bushels) for field crops, weight (tons) for hay, and carrying capacity (AUMs) for livestock. Regional subtotals are all calculated in these units. Provincial totals, however, are ranked according to the gross value of each specific product. Ten-year average prices (1973 to 1982) expressed in 1982 dollars were derived from the Index of Farm Prices for Agricultural Products. Livestock prices are a gross value based on an average gain for feeders of 65.58 pounds per month for five months (two pounds per day) of summer grazing at a price of $.706 per pound. By costing yearlings at the market price, the winter cow herd maintenance cost is taken into account in the economic report to derive a net value per AUM.

Wheat	1 bu = $ 5.02
Oats	1 bu = $ 1.72
Barley	1 bu = $ 2.80
Canola	1 bu = $ 7.86
Hay	1 ton = $81.74
Livestock	1 AUM = $46.30

Maps at 1:5 million scale were prepared to illustrate the provincial location and regional significance of each development alternative under consideration. The final maps illustrate the broad-scale statistical area refinements as discussed for each alternative. These maps were not used to generate statistical data for the inventory. Lines dividing specific areas represent broad transitional belts, there are no sharp changes from one region to the next. Through a system of multiple overlays, these final (composite) maps were produced using the following information.

Figure 3.2 - Agricultural Capability: Canada Land Inventory (CLI) maps present an evaluation of the lands capability for agricultural production. Only arable, CLI Class 1-4 lands are considered in the estimation of crop production increases. CLI Class 5 lands are only considered suitable for range improvement. CLI Class 6, 7, organic, unclassified, and lands not relevant to the management option being examined are deleted (appendix 2). Based on 1:1 million scale Canada Land Inventory Soil Capability for Agriculture, Lands Directorate, Ottawa, 1976.

Figure 3.3 - Current Agricultural Use: 1981 Census information documenting the amount of improved land (crop and rangeland) was examined: Improved cropland (Census) acreage estimates are subtracted from the total arable (CL 1-4) land base to determine the initial area suitable for agricultural expansion or intensification (Appendix 3). False-colour Landsat satellite images, representing green (Band 4), red (Band 5) and infrared (Band 7), illustrated the distribution of improved agricultural lands at a 1:1 million scale. Based on 1980-81 summer images from the Canada Centre for Remote Sensing (CCRS) Prince Albert, Saskatchewan.



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AGRICULTURAL LAND BASE STUDY

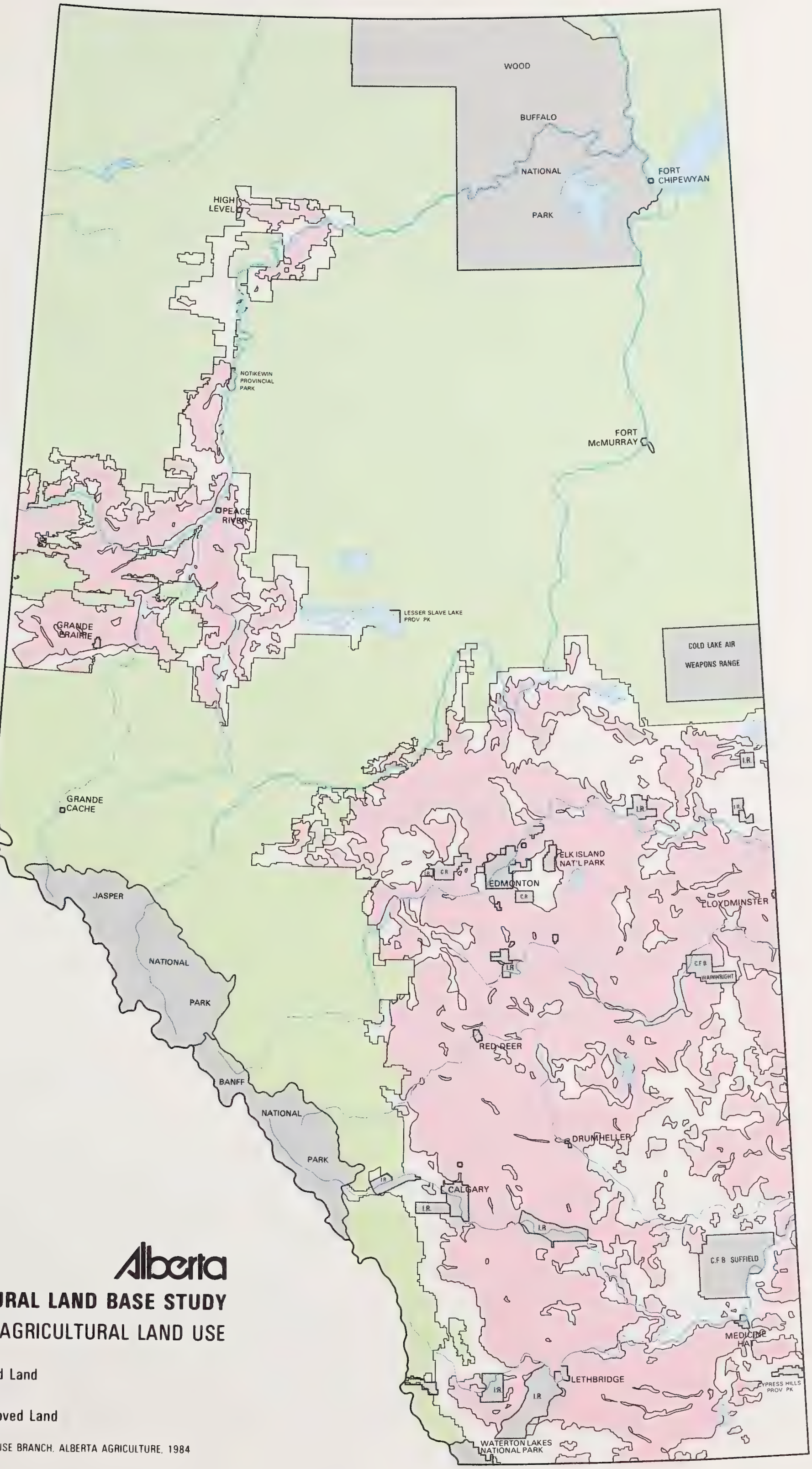
CLI AGRICULTURAL CAPABILITY CLASSES IN THE WHITE AREAS

🟨 CLI 1-4

🟧 CLI 5

🟫 CLI 6, 7 and Organic

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA ENERGY AND NATURAL RESOURCES, 1985.



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AGRICULTURAL LAND BASE STUDY

DOMINANT AGRICULTURAL LAND USE

🟥 Improved Land

☐ Umimproved Land

SOURCE LAND USE BRANCH, ALBERTA AGRICULTURE, 1984

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA ENERGY AND NATURAL RESOURCES, 1985.

4. RESULTS

4.1 Green Area Conversion

4.1.1 Introduction

In 1948, Alberta was divided into the Green, White and Yellow Areas for the administration of public lands. The Green Area, which covers over half of the province, corresponds to the forested non-settled lands. This area is managed primarily for forest production, watershed protection and multiple use, including unimproved grazing. Other agricultural uses have been restricted. Alberta Forestry, Lands and Wildlife is reponsible for the administration and management of these public lands.

Suitable public lands are periodically withdrawn from the Green Area for agricultural development. Canada Land Inventory (CLI) agricultural capability Class 1-4 lands are considered suitable for annual field crop production. The actual amount of new land withdrawn for agriculture has averaged approximately 20 000 acres annually in recent years. Most of this development and expansion occurs along the existing Green Area boundary and is located primarily in the Peace River District. Northwest Alberta is considered to be one of Canada's last remaining tracts of land with a physical potential for agricultural expansion.

4.1.2 Area Estimates

Data on the area and location of potentially arable land in the Green area were obtained from Alberta Forestry, Lands and Wildlife. Approximately 10.8 million acres of CLI Class 1-4 lands are located in the provincial Green Area. Additional CLI Class 1-4 lands in the unclassified regions of the Green Area will not be examined in this study. Table 4.1.1 shows the acreage of potentially arable lands in the Green Area. There are no CLI Class 1 lands and fewer than 100 000 acres of CLI Class 2 land in the Green Area. Almost all of the area under consideration is lower capability CLI Class 4 land.

TABLE 4.1.1

CLI SOIL CAPABILITY FOR AGRICULTURE

(Millions of acres)

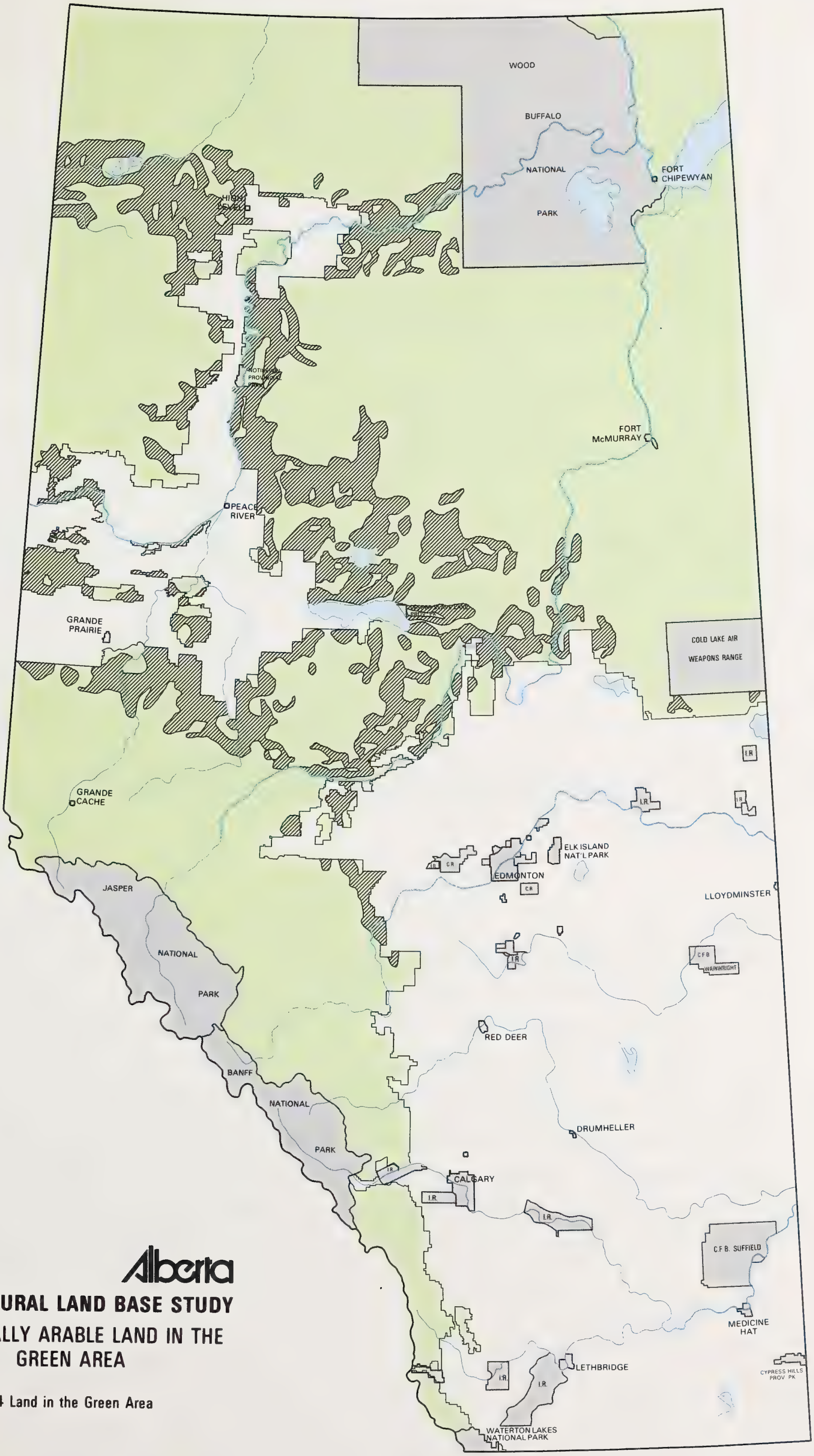
CLI	GRAY SOIL ZONE (Green Area)	% Dist.	GRAY SOIL ZONE (Peace)	% Dist.
1	0.00	0.0%	0.00	0.0%
2	0.05	0.5%	1.98	25.0%
3	0.99	9.2%	3.21	40.6%
4	9.64	89.3%	2.72	34.4%
TOTAL	10.80	100%	7.91	100%

Source: Soil Capability for Agriculture, ENR 1983.

CLI data were intended to be used for broad-level planning. Accordingly, not all of the 10.8 million acres that were identified may be physically suitable for agricultural expansion. The acreage estimates are reduced according to Public Lands Division information regarding posting of new lands for settlement. Where no other resource concerns exist, approximately 15 percent of the land (1.6 million acres) is not posted due to physical landscape limitations. Therefore, only 9.2 million acres of CLI 1-4 land in the Green Area are considered suitable for agricultural expansion.

4.1.3 Yield Estimates

No direct agricultural crop yield data is available for the currently undeveloped Green Area. A comparison between the distribution of CLI 1-4 lands in the Peace River and Green Area illustrates the predominance of lower quality CLI Class 4 lands in the Green Area. (Table 4.1.1). These Green Area lands are primarily Gray Luvisols which have developed under continuous tree cover. They contain less organic matter and have lower natural fertility than the Dark Gray and Dark Gray



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AGRICULTURAL LAND BASE STUDY

POTENTIALLY ARABLE LAND IN THE GREEN AREA

▨ CLI 1-4 Land in the Green Area

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA ENERGY AND NATURAL RESOURCES, 1985.

Luvisols which dominate the Peace River White Area. The following CLI productivity index has been prepared for the prairie provinces: CLI 1 (100%); CLI 2 (85%); CLI 3 (70%); and CLI 4 (50%) (Shields and Ferguson, 1975). Accordingly, existing Peace River yields are representative of the Green Area's lower production potential. Table 4.1.2 compares existing Peace River and predicted Green Area average crop yields.

Table 4.1.2

AVERAGE GRAY SOIL ZONE CROP YIELDS:
PEACE RIVER AND GREEN AREA
(bushels per acre)

Gray Soil Zones	Wheat	Oats	Barley	Canola	Hay[2]
Peace River[1]	29.9	55.8	38.6	16.5	1.91
Green Area (predicted)	23.5	43.9	30.3	13.0	1.50

1. Source: Agricultural Statistics Yearbook (1979-83)
2. tons/acre

4.1.4 Summary

Farming in northerly latitudes is strongly influenced by numerous climatic factors including the length of the frost-free period, the amount of precipitation, the heat units, and the hours of daylight. A shorter growing season, variability of precipitation, lower fertility, and susceptibility to water erosion are the major limiting factors. This may preclude the cultivation of higher value crops, such as wheat, which require a 100-120 day frost-free period to mature. Nevertheless, production increases are based on the same representative crop mix (including wheat) as in the Peace River area.

Assuming all of the 9.2 million acres were brought into crop production, the estimated increases in agricultural production and the value of these increases are listed in Table 4.1.3. These crop production increases, however, would result in an estimated loss of approximately 22 500 AUMs ($1.04 million) of unimproved grazing (Alberta Forest Service). Green Area Conversion would result in a net increase in production of $762 million ($763 million - $1 million).

Table 4.1.3.

INCREASED AGRICULTURAL PRODUCTION

GREEN AREA CONVERSION

	Wheat	Oats	Barley	Canola	Hay	Summer-fallow	Total
Crop Mix	18%	4%	30%	12%	16%	20%	100%
Acreage Dist. (millions of acres)	1.66	.37	2.76	1.10	1.47	1.84	9.2
Production (millions of bushels)	39.01	16.24	83.63	14.3	2.36[1]	---	---
Value of Production (millions of dollars)	195.83	27.93	234.16	112.40	192.91	---	763.23

[1] Millions of Tons

4.2. Irrigation Expansion

4.2.1 Introduction

Most of the province's irrigated lands are located in the semi-arid regions of south and south-central Alberta. A lack of sufficient rainfall severely limits plant growth in this region. Irrigation protects thousands of fertile acres that have adequate heat units and frost-free periods from drought-related crop failures. The amount of land that has the physical potential for irrigation is restricted by the limited volume of water available.

Irrigation is the practice by which natural precipitation is supplemented by the artificial application of water in order to maximize crop production. There are two common methods for applying water for irrigation in Alberta: gravity and sprinkler. In each instance, irrigation water requirements are met through river diversions using storage reservoirs and canal systems for distribution. The study of irrigation expansion is restricted to those lands lying south and east of Irrigation-Climatic Zone C, as defined in the South Saskatchewan River Basin Study, 1984. (Figure 4.2.1)

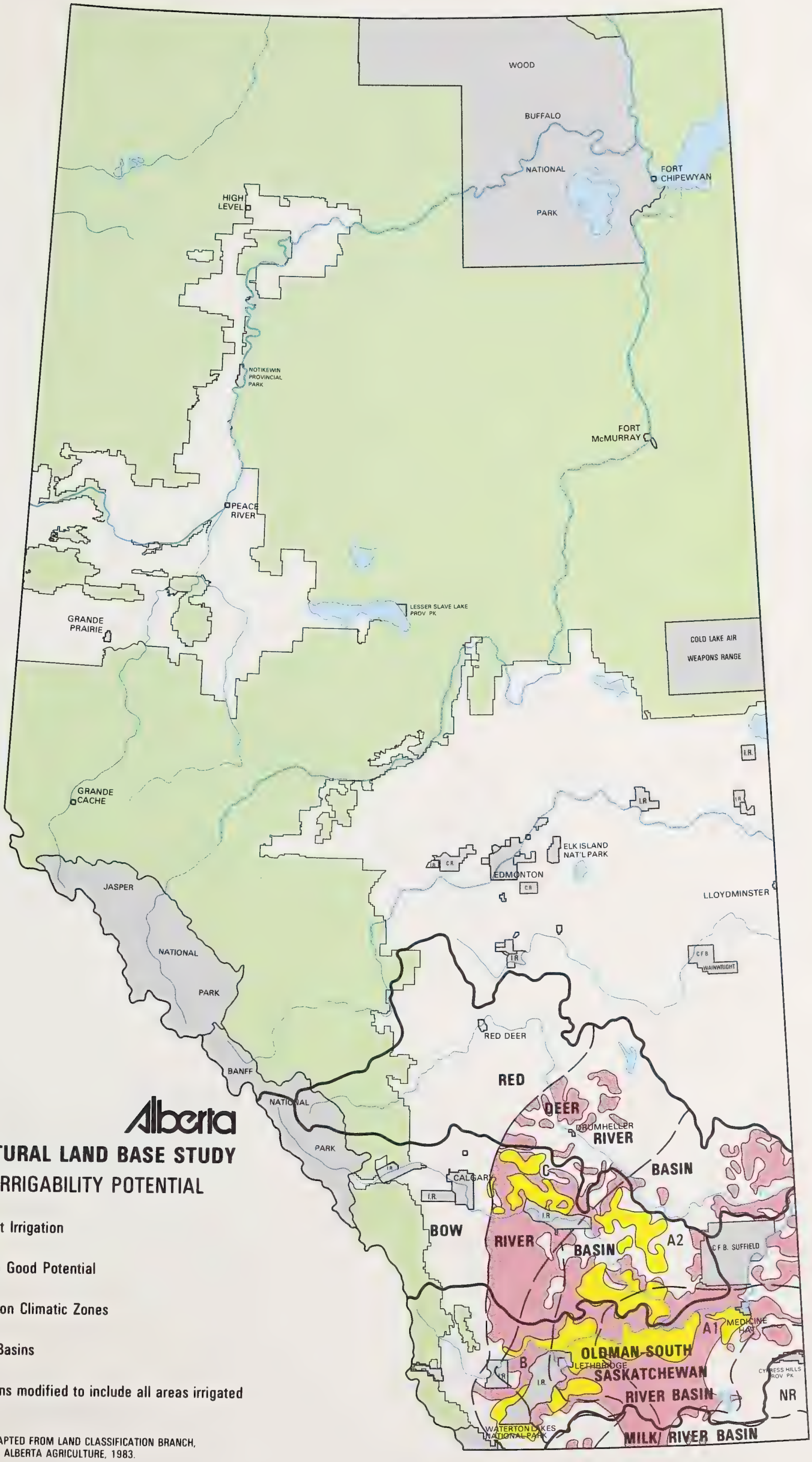
4.2.2 Area Estimates

Not all lands are physically suitable for irrigation. Irrigability classification reports, soil survey reports, air photo mosaics, and surficial geology reports were used to evaluate the potential irrigation for southern Alberta soils. Surface features and soil profile characteristics were evaluated and soils classified according to their physical potential for irrigation. Lands with fair to good potential for irrigation are defined as Soil Classes 1, 2 and 3 of the Land Irrigability Classification system. These lands have maximum water holding capacity balanced with a suitable water intake rate. This implies deep profile development, loamy texture, good drainage, low salt and sodium content, and level to slightly undulating relief. Within the Zone C boundary, approximately 8.9 million acres have fair to good physical potential for irrigation.

Physical potential notwithstanding, the most recent estimates of the land area which may be irrigated using existing water supplies are contained in the report of the South Saskatchewan River Basin Study. For the purposes of the Agricultural Land Base Study, the maximum irrigation expansion potential is based on existing water supplies within the South Saskatchewan river basin. These estimates consider that 50 percent of the total flows of the Bow, Red Deer and Oldman Rivers are required to be passed on to Saskatchewan to fulfill existing interprovincial water apportionment agreements. Under maximum expansion, water is available to irrigate a total of 2.3 million acres of land (includes currently irrigated lands). This total is considerably less than the 8.9 million acres originally identified as having fair to good physical capability, illustrating the limiting effects that water constraints have on the provincial potential for irrigation expansion.

Farmers pay an annual water rate for each acre of land on the assessment rolls of an Irrigation District (I.D.). Private projects outside the organized districts obtain a license for drawing water from Alberta Environment and pay no annual fees. The number of acres irrigated during a given year is dependent upon variations in precipitation, temperature and the availability of water. In 1983 a total of 1.1 million acres (Table 4.2.1). were serviced for irrigation; whereas only 0.97 million acres were actually irrigated. The ratio of assessed to actually irrigated lands within irrigation districts from 1974-83, was 82 percent. While licenses for some 200 000 acres have been issued, the South Saskatchewan River Basin Pilot Project Study estimate of 93 940 privately irrigated acres will be used for this analysis. The province-wide distribution of these private irrigation projects is illustrated in Figure 4.2.2.

Deletion of the currently serviced acreages, within irrigation districts (1.1 million acres) and private projects (.1 million acres), results in an estimated expansion acreage of 1.1 million acres. The distribution of these expansion estimates by irrigation-climatic zone are listed in Table 4.2.2. Figure 4.2.1 also illustrates lands with fair to good physical suitability, currently irrigated parcels, as well as the major river basins and irrigation climatic zones.



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AGRICULTURAL LAND BASE STUDY

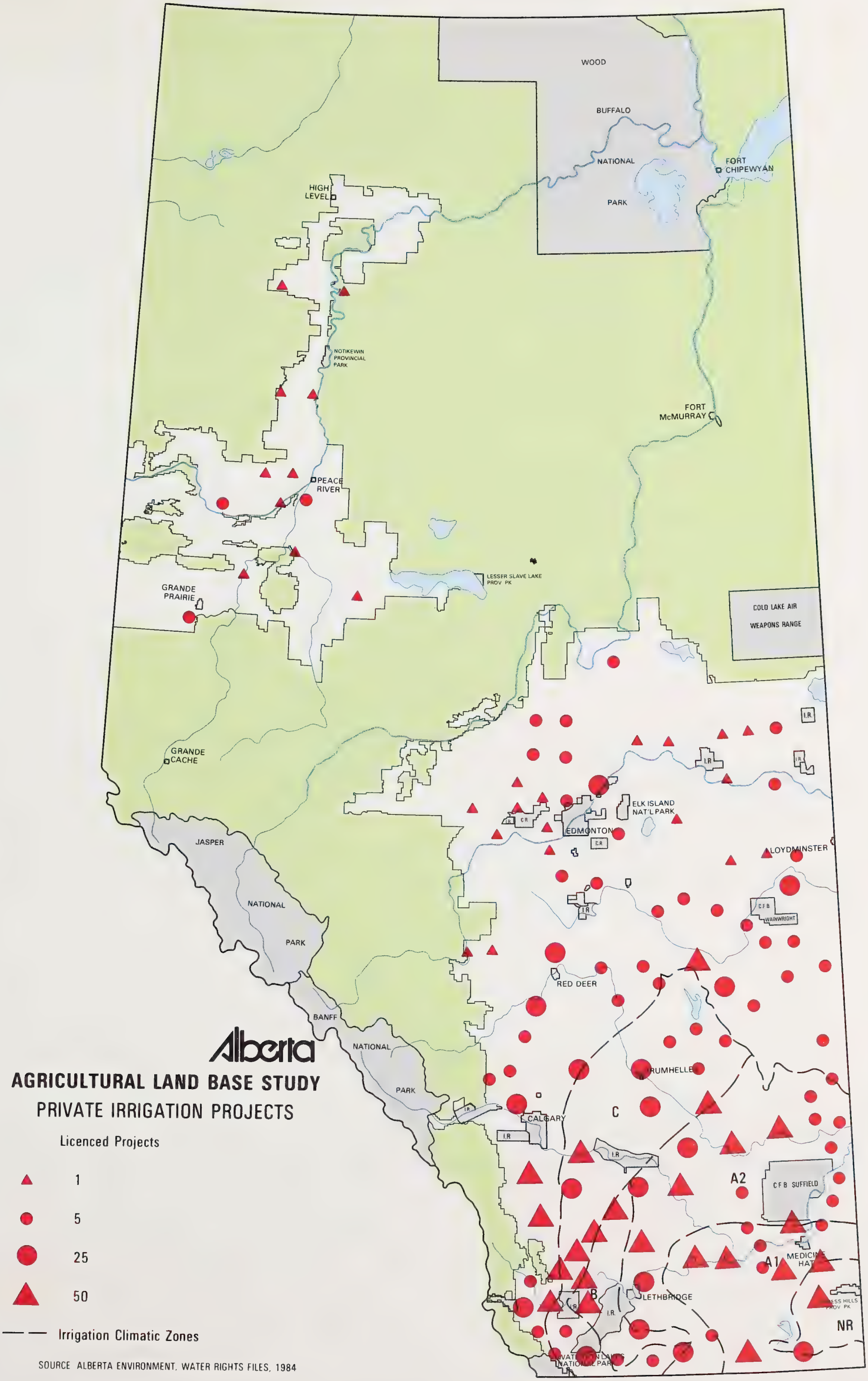
LAND IRRIGABILITY POTENTIAL

🟨	Current Irrigation
🟪	Fair to Good Potential
— —	Irrigation Climatic Zones
——	River Basins

NOTE: River basins modified to include all areas irrigated from that basin.

SOURCE: ADAPTED FROM LAND CLASSIFICATION BRANCH, ALBERTA AGRICULTURE, 1983.

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA ENERGY AND NATURAL RESOURCES, 1985.



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AGRICULTURAL LAND BASE STUDY

PRIVATE IRRIGATION PROJECTS

SOURCE ALBERTA ENVIRONMENT, WATER RIGHTS FILES, 1984

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA ENERGY AND NATURAL RESOURCES, 1985.

Table 4.2.1
SERVICED IRRIGATED ACREAGE 1983

Irrigation District	Serviced Acres
Aetna	2 916
Bow River	181 174
Eastern	244 099
Leavitt	4 440
Lethbridge Northern	116 745
Magrath	12 357
Mountain View	3 710
Raymond	39 148
Ross Creek	1 776
St. Mary	313 728
Taber	76 623
United	33 448
Western	83 265
TOTAL	1 109 429

4.2.3 Yield Estimates

Irrigated yields are typically much higher than dryland yields. Higher value crops and a wider range of crops may be grown with irrigation than under dryland conditions. Immediate increases in productivity range from 60 percent to 200 percent. Provided fertility is adequate, yield increases for various crops can be calculated according to specific quantities of moisture. Irrigation must supply crops with sufficient water over the entire growing season. Lack of water for even a short period of time will drastically reduce yields. Irrigated crops require special management techniques, land preparation, increased fertilization and drainage to produce higher yields. Approximately 35 different crops are grown on irrigated lands in southern Alberta. Yield responses for the major crops are listed in Table 4.2.3.

Table 4.2.2
IRRIGATION EXPANSION
AREA ESTIMATES

(acres)

Irrigation Climatic Zones[1]	Land with Fair to Good Physical Capability[2]	Maximum Irrigation Expansion Using Available Water Supplies[3]	Currently Serviced Lands[4]	Irrigation Expansion Potential Using Available Water Supplies
A1	2 589 000	679 000	397 000	282 000
A2	3 398 000	1 272 000	650 000	622 000
B	916 000	102 000	72 000	30 000
C	1 904 000	286 000	84 000	202 000
NR	--	--	--	--
TOTAL	8 896 000	2 339 000	1 203 000	1 136 000

1. Irrigation climatic zone A1 and A2 = Brown Soil Zone
   Irrication climatic zones B and C = Dark Brown Soil Zone
2. Adapted from Land Classification Branch, Alberta Agriculture
3. South Saskatchewan River Basin Study
4. Adapted from 1983 Agricultural Statistics Yearbook; including 93,950 acres of privately irrigated lands.

Table 4.2.3
ESTIMATED AVERAGE IRRIGATED CROP YIELDS
(bushels per acre)

Crop	Irrigation Climatic Zones A1	A2	B	C
Wheat	86.3	85.8	89.4	80.3
Barley/Other Grains	95.9	95.7	96.7	94.8
Canola/Oilseeds	46.1	47.9	47.9	48.2
Alfalfa/Seed	119.9	120.1	131.0	124.9
Dry Beans (Soy)	33.9	25.1	25.4	25.4
Potatoes	723.9	724.5	737.1	705.4
Peas	16.9	16.9	16.9	16.9
Corn/Canning Corn	199.2	199.0	150.2	95.4
Pasture (fescue meadow)[1]	3.1	3.1	3.0	2.8

Source: Strong-Hall and Associates, Marv Anderson and Associates Ltd., Environmental Management Associates, South Saskatchewan River Basin Planning Program: Evaluation Methologies and Data Base, 1973.

1. Tons/acre

4.2.4 Summary

Assuming all of the lands identified in were serviced by the necessary infrastructure of reservoirs and canals, the estimated net increases in production are listed in Table 4.2.4. Production estimates for irrigation expansion are estimated as incremental increases beyond current dryland crop production. It is the incremental change which provides the actual measure of increased agricultural production for this alternative. Irrigation expansion increases crop production substantially considering the natural aridity of the region. Proper water application practices, however, distribution system management and construction are essential to prevent salinization problems. Increasing Specialty crops was not considered because they can be increased on lands currently irrigated and because they are grown on comparatively few acres. Irrigation Expansion could result in an estimated net increase in production of $306 million.

Table 4.2.4

IRRIGATION EXPANSION

ESTIMATED[1] NET PRODUCTION INCREASES

	Wheat	Oats	Barley	Canola	Hay[1]
		(Millions of bushels)			(Millions of tons)
Brown[2]					
Dryland Yields[3]	10.26	0.75	2.39	0.16	0.04
Irrigated Yields[4]	41.96	1.73	14.72	0.43	0.73
Net Increase	31.70	0.98	12.33	0.27	0.69
Value of Production (Millions of Dollars)	159.12	1.68	34.51	2.08	56.45
Dark Brown					
Dryland Yields	3.03	0.42	2.01	0.22	0.02
Irrigated Yields	10.21	0.44	3.75	0.11	0.17
Net Increase	7.18	0.02	1.74	-0.11[5]	0.15
Value of Production Millions of Dollars)	36.01	0.04	4.88	-0.89	12.61
Total Value of Prod. (Millions of Dollars)	195.13	1.72	39.39	1.19	69.06
Total Value of Prod. (Millions of Dollars)	= 306.49				

1. Specialty crops are not included, as the increased acreages are insignificant in relation to the acreages of the five listed crops.
2. Brown soil zones = Irrigation-climatic zones A1 and A2.
   Dark Brown soil zones = Irrigation-climatic zones B and C.
3. Based on crop mix that includes current (1981) summerfallow acreages.
4. Based on adjusted crop mix (Wheat 54%, Oats 2%, Barley 17%, Canola 1%, Hay 26%, Summerfallow 0%).
5. Negative production increases are indicated for some crop types, because the switch from dryland to irrigation farming results in a change in crop, and hence the acreage distribution, from lower value (canola) to higher value (wheat) crops.

4.3. Drainage

4.3.1 Introduction

Much of the agricultural land base in Central and Northern Alberta is affected by excess moisture. In some areas of Central Alberta, potholes and sloughs are the most common type of wetland, often associated with undulating or "knob and kettle" topography. In the Northern portion of the Central White Area and in large areas of the Peace River region, organic soils form wetlands which may be classified as bogs (often consisting of accumulations of moss and usually acidic in nature) or fens (typically formed from accumulations of sedge material). In some of the level areas of the Peace River region, where heavy soils limit the rate of water percolation into the soil, large areas of "sheetwater" or temporarily flooded cultivated land can be found. In Southern and Central Alberta, where wetlands are less numerous, saline seeps comprise a larger fraction of the total wetland acreage.

On-farm drainage of agricultural land can involve a combination of several techniques. The most common approach is the construction of surface ditches. These may be constructed with broad side slopes to allow field equipment to cross easily. They may also be grassed to prevent soil erosion. Subsurface drains, commonly consisting of perforated plastic tubing, may also be used. Information on wetland acreage and drainage potential is taken from the report Drainage Potential in Alberta - An Integrated Study.

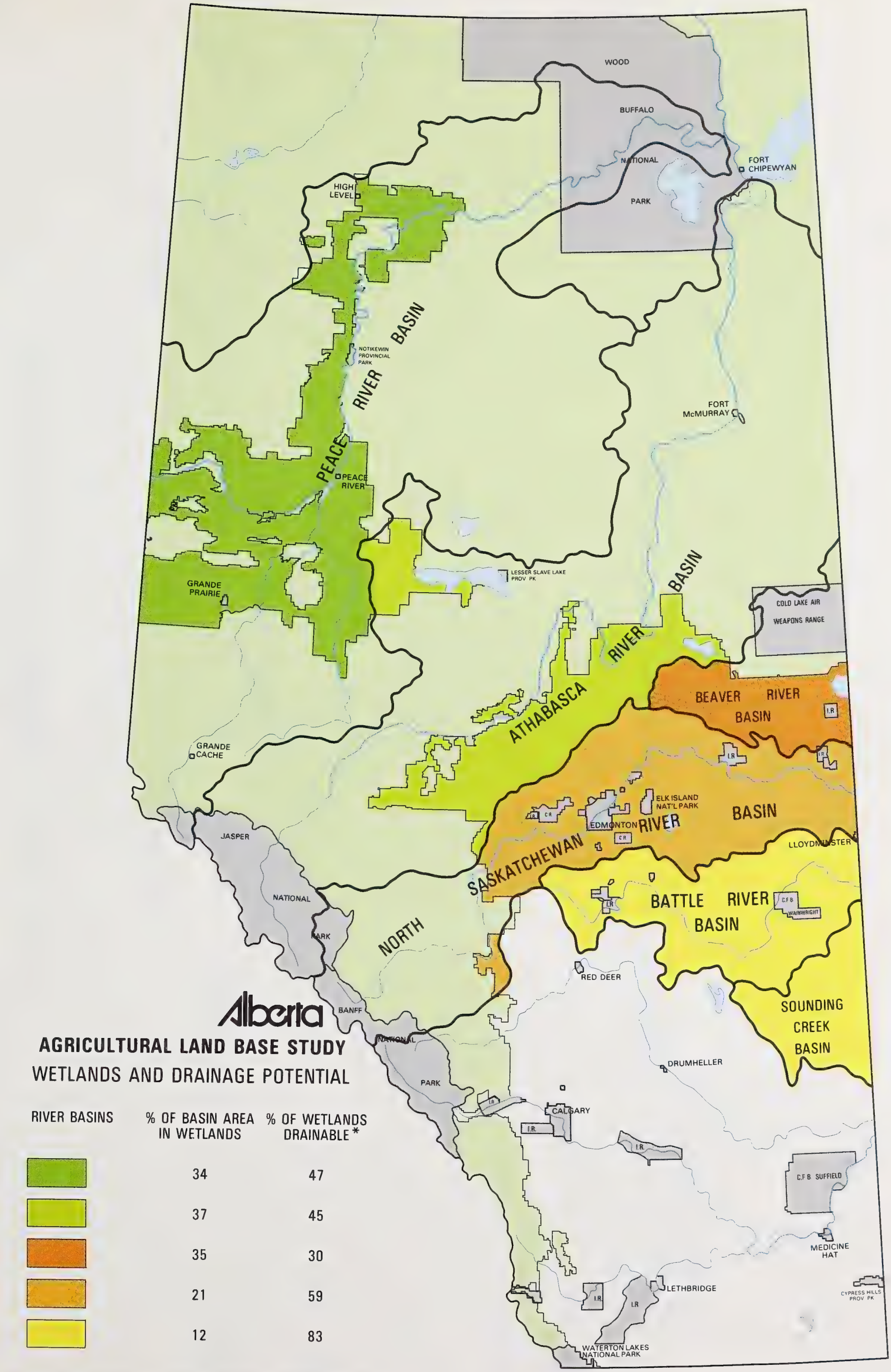
4.3.2 Area Estimates

The inventory was conducted to determine the extent and type of wetlands in the White Area, as well as several characteristics which would have a bearing on agricultural development potential and wildlife habitat quality. Six types of wetlands were distinquished: slough/marsh, lake/pond, bog/fen, sheetwater, seep and watercourse. The slough/marsh type was described as permanent or non-permanent. The identification of permanent slough/marsh was based on the presence of aquatic vegetation. The inventory of wetlands was conducted by interpreting aerial photographs from a sample of townships throughout the White Area. The river basins which were studied are shown in the Wetlands and Drainage Potential map. The results of the inventory, based on an extrapolation of the sample findings, are presented in Table 4.3.1.

The inventory results indicate that the total wetland acreage is concentrated in Central and Northern Alberta, with over 80 percent occurring North of, and including, the Battle River basin. For the purpose of the Agriculture Land Base Study, only 2.1 million acres of non-permanent wetlands were considered suitable for drainge. The drainage of non-permanent wetlands were deemed to be economically feasible, while permanent wetlands were not. Non-permanent wetlands include temporary sloughs/marshes, seeps and sheetwater.

Bogs and fens, peatlands, account for the largest acreage and are concentrated in the Peace and Athabasca River basins, and to a lesser degree in the Beaver and North Saskatchewan River basins in areas less intensively developed for agriculture. It was not possible to determine the potential drainability of these peatlands. However, independent estimates place the overall drainage potential of peatlands as high as 50 per cent, or an additional 2.7 million acres of potentially drainable acreage. This additional 2.7 million acres of peatlands (bogs and fens) have been excluded from all subsequent analyses.

The drainage potential study's classification system, for broad data analysis was based on a series of discrete river basins. The agricultural inventory's system for estimating potential production increases resulting from full implementation is based on soil zones. Accordingly, river basin acreage estimates were extrapolated into their soil zone counterparts for all subsequent analyses. The following distributional relationships were established: Gray (Peace) soil zone (100% Peace River Basin); Gray (Central) soil zone (100% Athabasca, 100% Beaver, and 40% Saskatchewan River Basins); Dark Brown soil zone (30% Battle River Basin); and Brown soil zone (20% Battle River Basin). Table 4.3.2 shows the total distribution for 2.1 million acres of non-permanent wetlands, suitable for draining, in the White Area portion of five river basins and soil zones in Central and Northern Alberta.



Alberta

AGRICULTURAL LAND BASE STUDY

WETLANDS AND DRAINAGE POTENTIAL

RIVER BASINS	% OF BASIN AREA IN WETLANDS	% OF WETLANDS DRAINABLE*
🟩	34	47
🟩	37	45
🟧	35	30
🟧	21	59
🟨	12	83

*INCLUDES NON-PERMANENT WETLANDS AND POTENTIALLY DRAINABLE PEATLANDS.

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA FORESTRY, LANDS AND WILDLIFE, 1986.

Table 4.3.1
DRAINAGE, SUMMARY OF WETLANDS INVENTORY BY RIVER BASIN[1]

River Basin	Basin Area	Non-Permanent				Permanent			
		Temporary Slough/Marsh	Sheetwater	Seep	Total Non-Permanent	Bog/Fen	Lake/Pond and Permanent Slough/Marsh	Watercourse	Total Wetlands
					(thousands of acres)				
Athabasca	5 391	52	111	0	163	1 460	292	82	1 997
Battle	8 317	830	0	6	836	0	86	87	1 009
Beaver	2 327	37	0	0	37	405	308	59	809
North Sask.	8 663	803	0	0	803	563	205	246	1 817
Peace	11 244	75	206	0	281	3 062	85	390	3 818
TOTAL WETLANDS	35 942	1 797	317	6	2 120	5 490	976	864	9 450

[1] Based on economic and physical considerations, non-permanent wetlands (temporary slough/marsh, seep and sheetwater) are the most suitable types of wetlands for agricultural drainage. Up to half the bog/fen type may also be suitable for drainage.

Table 4.3.2
DRAINABLE, NON-PERMANENT WETLANDS BY SOIL ZONES

Soil Zones	Peace	Athabasca	Beaver	N. Sask.	Battle	Totals
			RIVER BASINS (thousands of acres)			
Brown	---	---	---	---	167	167
D. Brown	---	---	---	---	251	251
Black	---	---	---	482	418	900
Gray (Central)	---	163	37	321	---	521
Gray (Peace)	281	---	---	---	---	281
TOTALS	281	163	37	803	836	2,119

4.3.3 Yield Estimates

Increases in agricultural production are achieved through the drainage of non-permanent wetlands for annual field crop production. It was assumed that drainage would be completed in the first year, before any land clearing was undertaken. Preparation of the non-permanent wetland areas would take up to two years and involve clearing, breaking of the soil, root and stone removal, and discing. Most crop production would begin in the fourth year. Prior to drainage, crop production on the non-permanent wetlands was assumed to be zero. Farmers responding to a drainage potential study questionnaire indicated that they expected crop productivity on reclaimed wetlands to be about the same as adjacent wetlands. Accordingly, upon reclamation yields for the five major crops examined were assumed to increase from zero to the established benchmark averages for each soil zone. Benchmark yields reflect an average of both stubble and fallow yields in crop rotations and crop mixes representative of current farming practices in each zone. Table 4.3.3 indicates the established productivity benchmarks for each soil zone.

TABLE 4.3.3
BENCHMARK YIELDS FOR THE MAJOR CROPS

	Benchmark Yields (bu/acre)				
Soil Zone	Wheat	Oats	Barley	Canola	Tame Hay (Tons/acre)
Black	35.3	63.0	48.8	22.5	1.5
Dark Brown	32.7	60.1	50.9	24.3	1.0
Brown	26.4	41.6*	44.1	18.0*	0.6
Gray (Central)	32.7	61.7	44.1	18.3	1.7
Gray (Peace)	29.9	55.8	38.6	16.5	1.6

Sources:

1. Agriculture Statistics Yearbook (1979-83).
2. Hail and Crop Insurance Corporation Data (1978-82); obtained from: Soil Inventory Data Base for Management and planning (SIDMAP).
3. Estimated Long-Term Average Hay Yields (Alberta Agriculture, 1985.)

* Less than 500 cases recorded to establish yield.

4.3.4 Summary

Increased crop production, improved crop quality within immediately surrounding lands, improved timing of operations, reduction in tillage overlap and improved field patterns and working efficiency were all considered to be agricultural benefits resulting from the drainage of non-permanent wetlands. Crop production increases from drainge are estimated solely from the cultivation of former wetland areas. Crop production increases differ among soil zones due to natural variations in productivity across the province and the amount of wetlands occurring in each specific zone. The drainage of 2.1 million acres, representing 22 percent of the non-permanent wetlands in Central and Northern Alberta would result in $241 million of agricultural production annually.

Drainage results are presented in Table 4.3.4 (by major crops) and Table 4.3.5 (by soil zones). The drainage of an additional 2.7 million acres of bog/fen (peatlands) wetlands could result in an additional increase in agricultural production valued in excess of $242 million annually.

TABLE 4.3.4
DRAINAGE, GROSS ANNUAL VALUE OF PRODUCTION BY CROPS

	Major Crops (millions of dollars)					
Soil Zones	Wheat	Oats	Barley	Canola	Hay	Totals
Brown	9.31	.24	1.24	.24	.57	11.60
D. Brown	16.06	.78	6.08	1.92	1.44	26.28
Black	33.48	6.82	44.25	11.14	17.65	113.34
Gray (Central)	6.84	5.53	18.65	2.25	28.22	61.49
Gray (Peace)	7.59	1.08	9.11	4.37	5.88	28.03
Totals	73.28	14.45	79.33	19.92	53.76	240.74

Table 4.3.5
DRAINAGE, GROSS ANNUAL VALUE OF PRODUCTION BY SOIL ZONES

	RIVER BASINS (millions of dollars)					
Soil Zones	Peace	Athabasca	Beaver	N. Sask.	Battle	Totals
Brown	---	---	---	---	60	11.60
D. Brown	---	---	---	---	26.28	26.28
Black	---	---	---	61.20	52.14	113.34
Gray (Central)	---	19.06	4.30	38.13	---	61.49
Gray (Peace)	28.03	---	---	---	---	28.03
TOTALS	29.03	19.06	4.30	99.33	90.02	$240.74

4.4. Deep Plowing

4.4.1 Introduction

Solonetzic soils adversely affect crop yields in Alberta. These soils are characterized by a tough impermeable hardpan that is high in exchangeable sodium (from 1 to 12 inches or more below the surface). This hardpan layer severely restricts root and water penetration which are vital to plant growth. Poor root penetration reduces moisture and nutrient uptake. Plant growth is restricted to the narrow band of soil between the hardpan layer and the surface. Poor water penetration creates drainage, storage and other water management problems.Solonetzic soils are often associated in a complex manner with normal soils and their productivity, which depends to a large extent on the depth of the topsoil, ranges from very low to near that of the associated normal soils. Crop yields also vary from year to year depending on the distribution of rainfall as more available moisture at the surface reduces the need for deeper root penetration. Solonetzic soils are distributed over a relatively large area of Alberta in both grain producing and mixed farming areas.

A number of management practices including deep plowing and ripping and liming have been developed to correct the problem. Although all of these have shown some degree of response, this report will deal strictly with deep plowing. Deep plowing is a soil-mixing process that physically breaks up the hardpan layer and brings calcium to the surface. If soil conditions are appropriate, deep plowing should be a one-time treatment, although the impermeable hardpan may redevelop over time.

4.4.2 Area Estimate

There are approximately 10.7 million acres of land influenced by solonetzic soils. While solonetzic soils are rather widespread throughout the province, not all solonetzic soils benefit from deep plowing. Solonetzic soils in the Peace River region are not considered suitable for deep plowing because these soils are solonetzic only in nature. This means that formation of the hardpan is due to their inherent high clay content rather than the typical development from parent materials naturally high in or enriched with sodium salts (J. Hermans, personal communication). The calcium layer is also too deep to be brought to the surface with deep-plowing. The Central Gray soil zone has also been excluded due to the minor occurrence of solonetzic soils and because no deep plowing yield information is available. Only arable (CLI Class 1-4) lands are considered for this analysis.

Not all of the solonetzic soils respond equally to deep plowing. According to information collected to date, approximately 60 percent of the solonetzic soils in the Thin Black and Dark Brown soil zones and 40 percent in the Black and Brown soil zones may respond to deep plowing. (J. Hermans, personal communication). Table 4.4.1 shows the acreage. Figure 4.4.1 shows the areas that are expected to benefit from deep plowing.

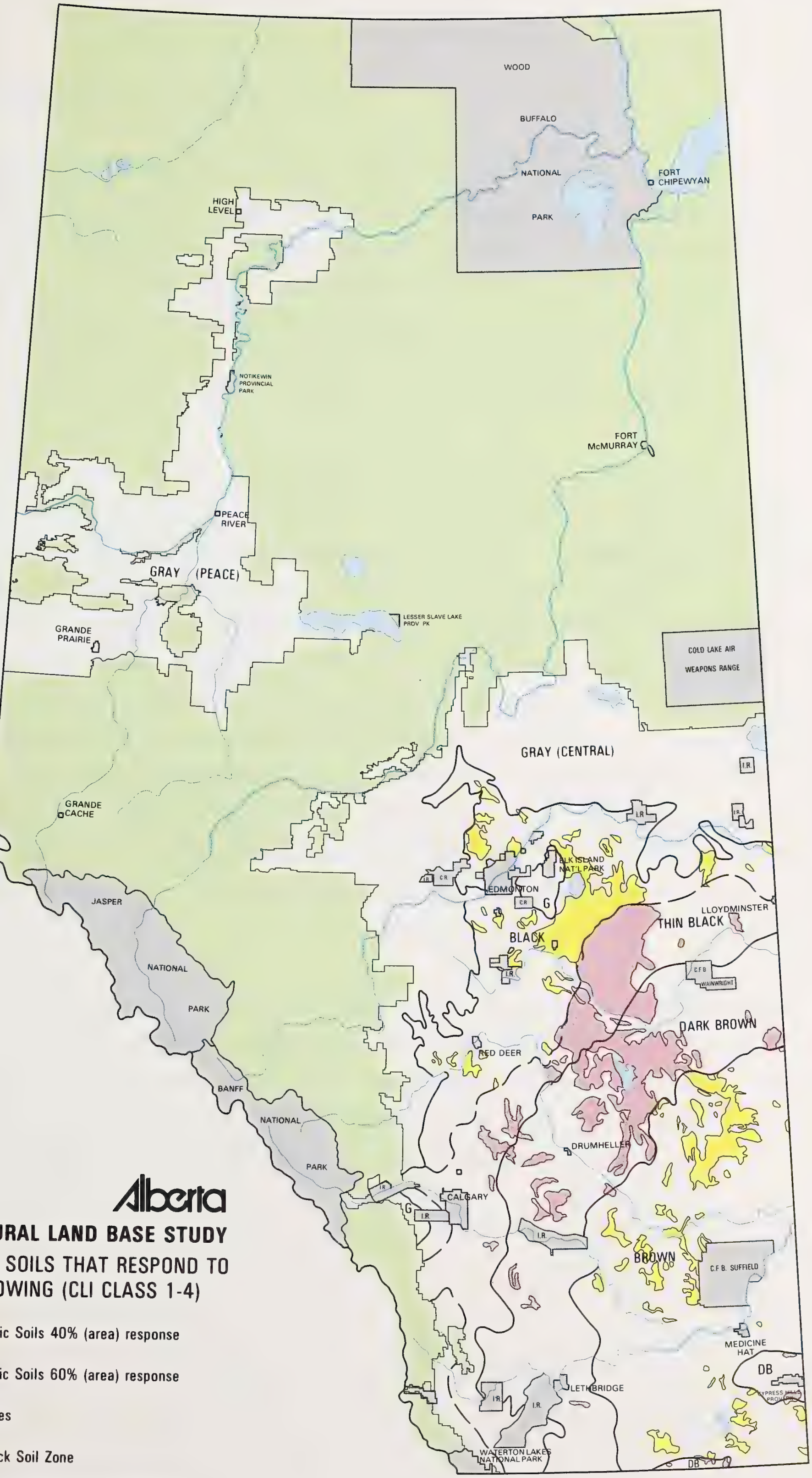
Table 4.4.1

ACREAGE AVAILABLE FOR DEEP PLOWING

(Millions of Acres)

Soil Zone	Initial Acreage Identified[1]	Refined Acreage Estimate[2]	Acreage That Will Potentially Respond to Deep Plowing
Black			
Northern portion	1.45	1.31	(40%) 0.52
Thin black portion	1.45	1.09	(60%) 0.65
Dark Brown	1.18	0.89	(60%) 0.53
Brown	3.72	1.30	(40%) 0.52
Gray (Central)	0.32	0.0	0.0
Gray (Peace)[3]	2.53	0.0	0.0
Provincial Total	10.65	4.59	2.22

1. Source: Peters T.W. (1982) Solonetzic Soils of Alberta. Compiled from information collected by the Alberta Soil Survey.
2. Excludes the Peace River area and CLI 5, 6, 7, 0 and N/C.
3. A small portion of this acreage is actually within the Green Area boundary.



Alberta

AGRICULTURAL LAND BASE STUDY

SOLONETZIC SOILS THAT RESPOND TO DEEP PLOWING (CLI CLASS 1-4)

🟨	Solonetzic Soils 40% (area) response
🟥	Solonetzic Soils 60% (area) response
———	Soil Zones
— —	Thin Black Soil Zone

SOURCE LAND USE BRANCH, ALBERTA AGRICULTURE, 1985

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA ENERGY AND NATURAL RESOURCES, 1985.

4.4.3 Yield Estimates

Increased yields on solonetzic soils can be achieved through deep plowing. Crop response to deep plowing varies from site to site and from year to year. Generally, crops respond to deep plowing because it provides better rooting depth and greater moisture storing capacity. Good responses occur in years when adequate moisture has been stored previously. The calculated increase in yield after deep plowing was derived from field plot data (Soils Branch of Alberta Agriculture).

Only three soil zones were examined. the Black, Dark Brown, and Brown. Soils in the Dark Brown and the Thin Black portion of the Black Soil Zone responded best to deep plowing. Some good results have been achieved in the Brown Soil Zone. Moisture deficiencies in the Brown Zone, however, continue to reduce crop yields on deep plowed sites. Good results have also been achieved on deep plowed sites in the Black Soil Zone. The Black Soil Zone is generally the most productive, and during years of adequate amounts and distribution of rainfall, even the solonetzic soils produce reasonably good yields. Problems may occur, however, when moisture is lacking or when intense rainfall results in ponding because the water cannot penetrate the hardpan. Response may also be limited when the lime-salt layer is too deep to be brought up by the plow.

The yield increases of wheat, oats, barley and canola are shown in Table 4.4.2. No yield information was available for hay, miscellaneous crops or canola on Brown soils and the representative crop mix was adjusted to accommodate these deletions. As well, no yield statistics are available for the Luvisolic areas of the province.

TABLE 4.4.2
INCREASE IN CROP PRODUCTION

(Bushels per Acre)

Soil zones		Wheat	Oats	Barley	Canola (tons/ac)
Black*	Yield on solonetzic[1] soil	29.5	47.9	47.2	20.6
	Predicted yield	42.2	66.6	72.7	27.0
	Yield Increase[2]	12.7	18.7	25.5	6.4
Dark Brown	Yield on solonetzic soil	24.6	35.6	37.1	18.7
	Predicted Yield	32.0	51.3	41.6	Insufficient Data
	Yield Increase	7.4	15.7	4.5	
Brown	Yield on solonetzic soil	20.6	37.4	37.0	
	Predicted Yield	26.0	61.7	45.1	No data are Available
	Yield Increase	5.4	24.3	8.1	

*Plot data for this soil zone are primarily from the thin black portion of the black soil zone

Sources: 1. Hail and Crop Insurance Corporation Data (1978-82) obtained from Soil Inventory Data Base for Management and Planning (SIDMAP).

2. Based on Soils Branch deep plowing field plots (1976-83). See Appendix. Hay results are not available.

4.4.4 Summary

Deep plowing is used to overcome structural problems on specific soils. It is a recommended practice on solonetzic soils and is not generally recommended for tillage. Probably only a small percentage of the total solonetzic soils respond to deep plowing. Soil specialists should be consulted concerning which soil types may benefit and which cannot be improved, or may be harmed, by deep plowing.

Final examination of this management option indicates that deep plowing solonetzic soils would increase agricultural production. The acreage that would respond to deep plowing is evenly distributed among the Black, Thin Black, Dark Brown and Brown soil zones. The Black soil zone, or more precisely, the Thin Black portion of that zone, shows the largest yield increase after deep plowing. Table 4.4.3 shows the increase in agricultural production in the prairie that could result from deep plowing solonetzic soils. Deep plowing could result in a net increase in production equal to $83 million.

TABLE 4.4.3

PROVINCIAL AND REGIONAL INCREASES IN PRODUCTION[1]

(Millions of Bushels)

SOIL ZONE	WHEAT	OATS	BARLEY	CANOLA
Black				
Northern portion	1.66	0.88	5.85	0.30
Thin Black	2.07	1.10	7.32	0.38
Dark Brown	1.68	0.33	0.47	0
Brown	1.41	0.25	0.30	0
PROVINCIAL TOTAL	6.82	2.56	13.94	0.68
VALUE OF PRODUCTION (Millions of Dollars)	34.24	4.40	39.03	5.34

1. Based on a crop mix that includes current (1981) summerfallow acreages.

4.5. Liming

4.5.1 Introduction

Soil reaction expressed as pH, refers to the acidity or alkalinity of a soil. Soil pH affects the physical, chemical and biological properties of soils, which, in turn, affect nutrient availability and crop production. For practical purposes, soils with pH 6.0 are considered acid. Potentially acid soils have a pH range of 6.1 to 6.5; soils are considered neutral at pH 6.5 to 7.5, the ideal range for most agricultural crops.

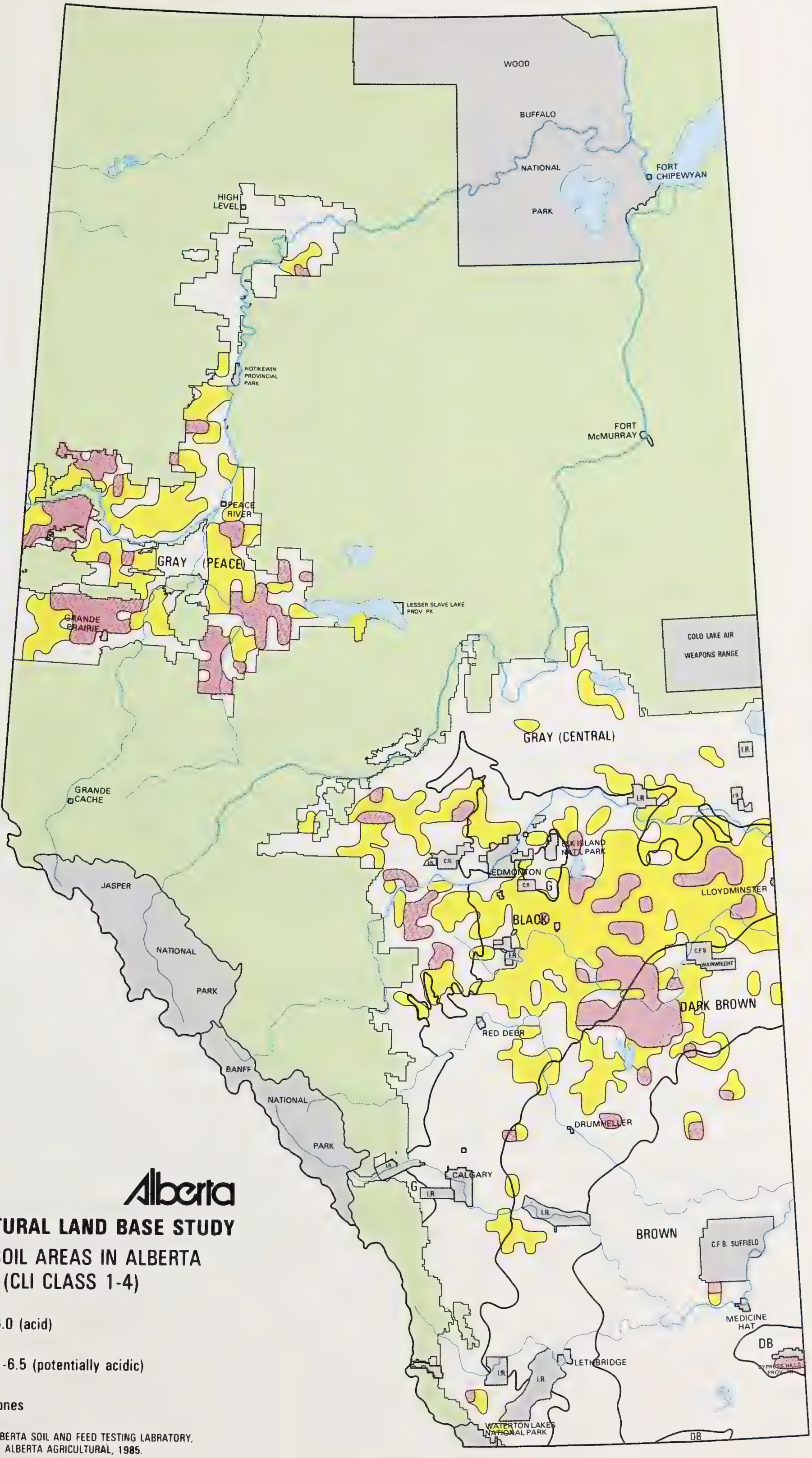
Seventy percent of the acid soils in western Canada are found in Alberta. Acid soils occur naturally due to acidic parent material or leaching of alkaline materials during soil formation. They also result from men's activities such as tillage and the use offertilizer.

The major cause of yield reductions on acid soils is crop toxicity to soluble aluminium and manganese at lower pH levels. As soils become more acid, soluble aluminium and manganese is released. Nitrogen-fixing bacteria are not active in acid soils. Cereal and oilseed crops vary greatly in their tolerance to acidity, and different varieties of a crop may also show ranging sensitivities to soil acidity. To overcome the problems of soil acidity, acid tolerant crops can be grown or lime can be applied to neutralize the soil. Ground limestone and marl are the most common liming materials. Limestone rock is found along the eastern slopes of the Rocky Mountains, while marl, an unconsolidated material containing calcium carbonate, usually occurs in bogs and shallow lakes. Application rates depend on the amount of the acidity, buffering capacity and the effectiveness of the liming material. Maintaining the soil at a desirable pH level requires about 0.89 tons of lime per acre every 5 to 10 years depending on cropping practices, fertilizer rates and soil type.

4.5.2 Area Estimates

Lands considered suitable for liming were restricted to arable CLI Class 1-4 lands in the White Area. The largest concentration of acid soils is found in the Peace River Luvisols. Soils in this region tend to be acidic due to the influence of parent material and vegetation. The decomposition of fallen leaves and needles under a forest canopy produces organic acids which leach alkaline materials downward. A large area of acid soils also occurs in the Black and Dark Brown soils of east-central Alberta. Many of these acid soils are associated with solonetzic soils which tend to have an acidic surface layer. The narrow band of permeable soils above the solonetzic barrier are often subject to waterlogging and droughty conditions which result in a low soil pH.

Table 4.5.1 summarizes acid soil acreage prior to and after solonetzic soil exclusion on cultivated lands. Acid soils associated with solonetzic soils that respond to deep plowing are not included in the final acid soil area estimate. These lands are addressed in the Deep Plowing development alternative. Fifty (50) percent of acid soils associated with solonetzic soils that do not respond to deep plowing can be ripped and limed. These soils are included in the final acid soil area estimate. The remaining fifty (50) percent have excessive physical limitations (that is, solonetzic, acid, saline, etc.) and do not warrant liming. Figure 4.5.1 illustrates the general location and distribution of acid soils. The map is generated from Agricultural Soil and Feed Testing Laboratory data which summarize average pH per township based on quarter section pH data from 1970 to 1983.



Alberta

AGRICULTURAL LAND BASE STUDY

ACID SOIL AREAS IN ALBERTA
(CLI CLASS 1-4)

🟥 pH ≤ 6.0 (acid)

🟨 pH 6.1-6.5 (potentially acidic)

— Soil Zones

SOURCE: ALBERTA SOIL AND FEED TESTING LABRATORY,
ALBERTA AGRICULTURAL, 1985.

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA ENERGY AND NATURAL RESOURCES, 1985.

Table 4.5.1

ACID SOIL ACREAGE ON CULTIVATED LANDS BY SOIL ZONES

(Millions of Acres)

SOIL ZONE	INITIAL ACREAGE (PRIOR TO SOLONETZIC SOIL EXCLUSION)[1]	FINAL ACREAGE (AFTER SOLONETZIC SOIL EXCLUSION)[2,3,4]
Black	2.15	0.94
Dark Brown	0.72	0.23
Brown	0.23	0.09
Gray (Central)	0.31	0.31
Gray (Peace)	1.03	1.03
Provincial Total	4.44	2.61

Sources:
1. Area Estimates of Major Soil Fertility Factors For Alberta. Agricultural Soil and Feed Testing Laboratory, Alberta Agriculture, January, 1985.
2. Personal communication with D. Penney (Soils Branch, Alberta Agriculture, December 1984).
3. Solonetzic Soils of Alberta (Alberta Soil Survey 1982).
4. Personal communication with John Hermans (Conservation and Development Branch, Alberta Agriculture).

Alberta, excluding the Peace River Area, has approximately 4.8 million potentially acidic (ph 6.1-6.5) cultivated acres. The Peace River Area contains approximately 1.34 million potentially acidic cultivated acres. The pH of soils in Alberta is declining due to the use of fertilizers. In the future, millions of acres of potentially acidic soils may become acidic due to nitrogen fertilizer use. The location and distribution of these potentially acidic soils are also illustrated in Figure 4.5.1. The potentially acidic acreages are not included in the estimated yield increases.

4.5.3 Yield Estimates

Increases in agricultural production achieved through the liming of acid soils are expressed as increases in bushels per acre in Table 4.5.2. Of the four crops, oats are most tolerant to acidity; wheat and canola are moderately tolerant; while barley is quite sensitive. Crop sensitivity to acidity and response to liming does not vary with soil zone but is consistent across the province. Several sources of information were averaged to arrive at a percent yield reduction resulting from acidity. Averaged values per crop came from different varieties to remove the bias towards one variety which may show a different tolerance to acidity.

4.5.4 Summary

Table 4.5.3 shows the resulting provincial and regional increase in agricultural production if acid soils are limed. The crop mix was recalculated to address the lack of yield response data for hay and miscellaneous crops.

Provincial results indicate that liming substantially increases agricultural production. With response to liming being consistent across the province, those soil zones with the largest acid soil acreage, namely the Black and Gray (Peace) soil zones show the largest increase in agricultural production after liming. Liming has been a long-standing practice for neutralizing acid soils in Alberta. Assuming the 2.61 million acres of acid soils are limed over a ten-year period, at the end of 10 years approximately 235 000 tons of lime may be required annually to maintain these soils at a desirable pH level. The increased use of fertilizers on potentially acid soils will accelerate acidification and the demand for liming materials in the future. Liming could result in a net increase in production of $50 million.

Table 4.5.2
CROP PRODUCTION INCREASE
(Bushels per Acre)

SOIL ZONES		WHEAT	OATS	BARLEY	CANOLA
Black	Yield on acid Soil (pH 6)	29.6 (16)[2]	58.0 (8)	39.0 (20)	18.9 (16)
	Yield on limed Soil (pH 6.5)[1]	35.3	63.0	48.8	22.5
	Productivity Increase	5.7	5.0	9.8	3.6
Dark Brown	Yield on acid soil (pH 6)	27.5 (16)	55.3 (8)	40.7 (20)	20.4 (16)
	Yield on limed Soil (pH 6.5)[1]	32.7	60.1	50.9	24.3
	Productivity Increase	5.2	4.8	10.2	3.9
Brown	Yield on acid soil (pH 6)	22.3 (16)	38.3 (8)	35.3 (20)	15.1 (16)
	Yield on limed Soil (pH 6.5)[1]	26.4	41.6	44.1	18.0
	Productivity Increase	4.1	3.3	8.8	2.9
Gray (Central)	Yield on acid soil (pH 6)	27.5 (16)	56.8 (8)	35.3 (20)	15.4 (16)
	Yield on limed Soil (pH 6.5)[1]	32.7	61.7	44.1	18.3
	Productivity Increase	5.2	4.9	8.8	2.9
Gray (Peace)	Yield on acid Soil (pH 6)	25.1 (16)	51.3 (8)	30.9 (20)	13.9 (16)
	Yield on limed Soil (pH 6.5)[1]	29.9	55.8	38.6	16.5
	Productivity Increase	4.8	4.5	7.7	2.6
Provincial Productivity Increase		25.0	22.5	45.3	15.9

1. Yields on limed soils are equal to benchmark yields.
2. Numbers in parentheses indicate the reduction in percent from the benchmark yield.

Sources:
1. Farming Acid Soils in Alberta and Northeastern British Columbia (Agriculture Canada 1982).
2. Gray Wooded Soils and Their Management (Bentley et al. 1971).
3. An Assessment of the Soil Acidity Problem in Alberta and Northeastern British Columbia (Penney et al. 1977).
4. Does It Pay to Lime Acid Soils in Alberta? (A case of Peace River Region) (Hanus 1981).
5. Personal communication with D. Penney (Soils Branch, Alta. Agriculture, March 1984).

Table 4.5.3
INCREASE IN PRODUCTION[1] - LIMING
(Millions of Bushels)

Soil Zone	Wheat	Oats	Barley	Canola
Black	1.34	0.42	4.05	0.30
Dark Brown	0.51	0.044	0.46	0.045
Brown	0.18	0.009	0.059	0.003
Gray (Central)	0.24	0.27	1.37	0.054
Gray (Peace)	1.14	0.23	2.93	0.40
PROVINCIAL TOTAL	3.41	0.98	8.87	0.81
VALUE OF PRODUCTION (Millions of Dollars)	17.12	1.69	24.84	6.37

[1] Based on crop mix that includes current (1981) Summerfallow Acreages.

4.6. Summerfallow Reduction

4.6.1 Introduction

Summerfallow is cultivated land that is left uncropped during the growing season. Since the dry years of the 1930s, summerfallowing has been an integral part of crop rotations throughout the province, especially in the low-moisture regions of southern Alberta. The perceived advantages of fallowing include weed control, moisture storage, and accumulation of plant nutrients, particularly nitrogen, all of which contribute to higher yields. Increased soil moisture may mean more dependable production due to more consistent yields, except in years of extreme drought.

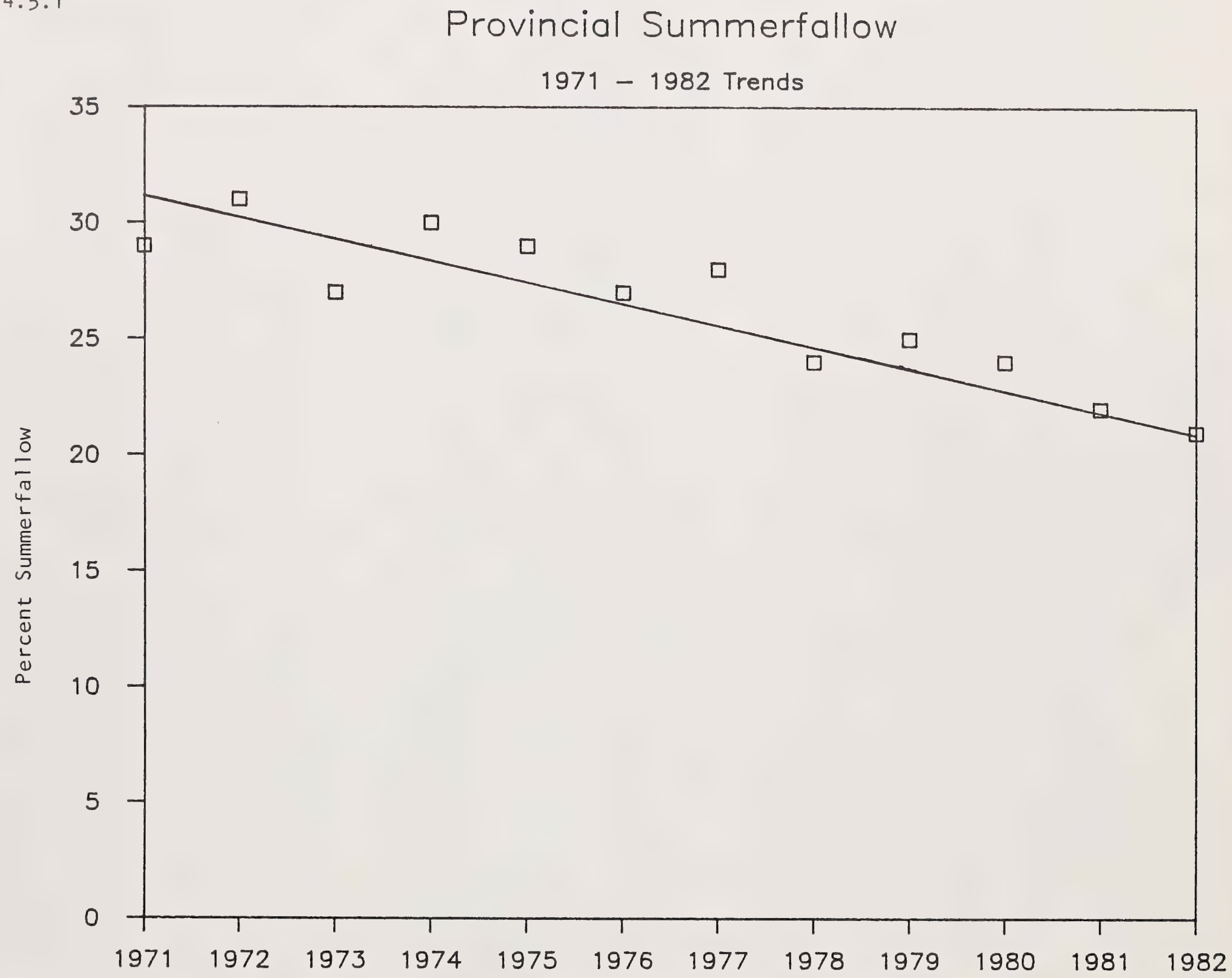
The increased usage of fertilizers and herbicides for soil fertility and weed control has decreased the advantages of fallow yield. This reduction in yield advantages varies substantially from one region of the province to another usually in relation to annual precipitation. Lower yield advantages and research documenting soil degradation processes indicate that a reduction in summerfallow acreage is both practical and necessary. Decreased soil organic matter, erosion, and salinity are examples of soil degradation processes.

4.6.2 Area Estimates

The acreage available for crop production after reduction of summerfallow is based on the 1981 Census of Agriculture. Irrigated acreage is not included in the calculations because there is little (one percent) of fallow on irrigated lands. Provincially, the trend over the last 10 years has been towards a reduction in fallow acreage. This has resulted in fallow reductions in all soil zones except the Brown. Fallow acreage values from the most recent census year (Figure 4.6.1) reflect lower summerfallow acreage in current farming practices.

Acreage estimates were made using projected summerfallow estimates from the Canada Grains Council report and the Hedlin report. Potential acreages are shown in Table 4.6.1.

Figure 4.5.1



Source - Factors Affecting summerfallow Acreage in Alberta (ECA 1981).

Table 4.6.1
ACREAGE AVAILABLE FOR CROP PRODUCTION AFTER SUMMERFALLOW REDUCTION
(Millions of Acres)

SOIL ZONE	TOTAL CULTIVATED ACREAGE 1981[1,2]	SUMMERFALLOW ACREAGE OF TOTAL CULTIVATED ACREAGE 1981 (PERCENT)	1981 SUMMERFALLOW ACREAGE	PROJECTED PROPORTION OF LAND DEVOTED TO SUMMERFALLOW[3] 1990 (PERCENT)	SUMMERFALLOW ACREAGE AFTER REDUCTION	PERCENT OPPORTUNITY FOR REDUCTION	ACRE AVAILABLE FOR CROP PRODUCTION
Black	9.71	13	1.23	10	0.97	3	0.26
Dark Brown	5.10	29	1.48	20	1.02	9	0.46
Brown	4.15	41	1.69	30	1.24	11	0.45
Gray (Central)	2.54	11	0.28	10	0.25	1	0.03
Gray (Peace)	3.82	20	0.75	15	0.57	5	0.18
Provincial Total	25.32	21	5.44	16	4.06	5	1.37

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(1) 1981 figures adapted from Alberta Census of Agriculture 1981 (Alberta Agriculture)

(2) Total cultivated acreage includes dryland crops plus summerfallow. Improved pasture is not included due to the definition in the census and major occurrence on non-arable lands.

(3) Based on "Prospects for the Prairie Grain Industry 1990" (Canada Grains Council 1982) and "The Place of Summerfallow in Agriculture on the Canadian Prairies" (Hedlin, 1980).

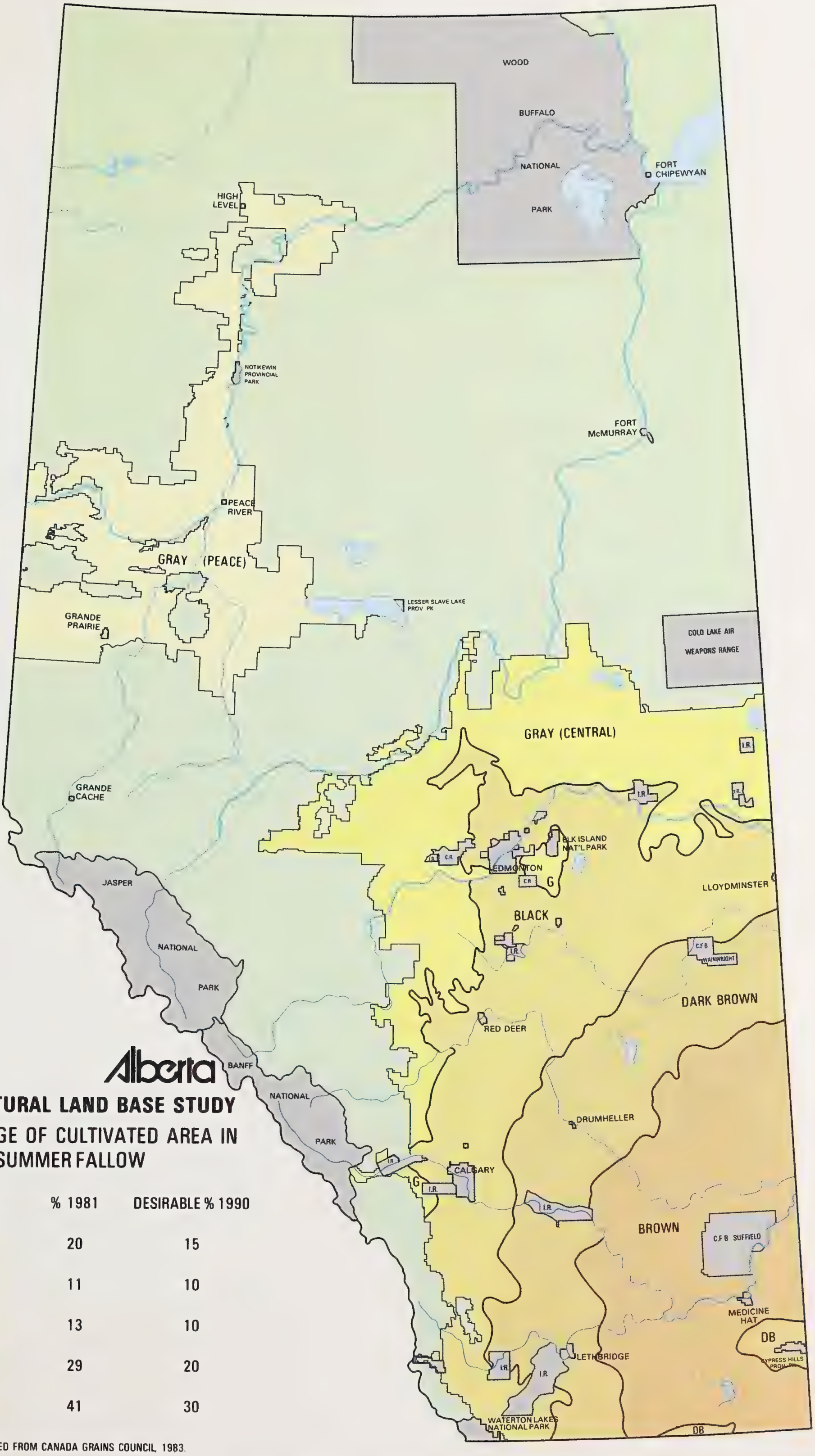
(4) Summerfallow acreage after reduction is based on 1981 total cultivated acreage from the Census.

Projections for summerfallow reduction indicate that the percentages of fallow in today's farming practices are not ideal. Through increased fertilization, the use of advanced herbicides for better weed control, and moisture conservation techniques such as reduced tillage and snow management, summerfallow can be reduced in all soil zones while maintaining the average crop productivity. The projected proportion of land devoted to summerfallow differs among the soil zones due to limitations such as moisture. Moisture stress areas, such as the Brown Soil Zone and, to a lesser extent the Dark Brown soil zone, still require significant amounts of fallow. Fallow reductions below those outlined by Canada Grains Council and Hedlin would probably not maintain average crop yields and, are therefore, not recommended.

Figure 4.6.2 shows the cultivated area of the province with 1981 and projected 1990 summerfallow percentage in each soil zone.

4.6.3 Yield Estimates

Agricultural production increases achieved through the reduction of summerfallow are expressed as bushels per acre. When fallowed land is put into production, yields for the four crops increase from zero to the benchmark averages for all soil zones. Benchmark yields reflect an average of both fallow and stubble yields in crop rotations that are representative of current farming practises in each soil zone. When summerfallow is reduced, thereby changing crop rotations, it is assumed that benchmark yields will remain constant. Table 4.6.2 illustrates the established benchmarks for each soil zone.



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AGRICULTURAL LAND BASE STUDY

PERCENTAGE OF CULTIVATED AREA IN SUMMER FALLOW

SOIL ZONE	% 1981	DESIRABLE % 1990
▨	20	15
▨	11	10
▨	13	10
▨	29	20
▨	41	30

ADAPTED FROM CANADA GRAINS COUNCIL, 1983.

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA ENERGY AND NATURAL RESOURCES, 1985.

Table 4.6.2

BENCHMARK CROP YIELDS FOR THE MAJOR DRYLAND CROPS BY SOIL ZONE

Soil Zone	Wheat	Oats	Barley	Canola	Tame Hay
		(bu/acre)			tons/ac
Black	35.3	63.0	48.8	22.5	1.5
Dark Brown	32.7	60.1	50.9	24.3	1.0
Brown	26.4	41.6*	44.1	18.0*	0.6
Gray (Central)	32.7	61.7	44.1	18.3*	1.7
Gray (Peace)	29.9	55.8	38.6	16.5	1.6

Sources:

1. Agriculture Statistics Yearbook (1979-83).
2. Hail and Crop Insurance Corporation Data (1978-1982) obtained from: Soil Inventory Data Base for Management and Planning (SIDMAP)
3. Estimated Long-Term Average Hay Yields (Alberta Agriculture 1985).

* Less than 500 cases recorded to establish yield.

4.6.4 Summary

Table 4.6.3 shows the increases in agricultural production for regions and for the province resulting from a reduction in summerfallow. The crop mix was recalculated to address the lack of benchmark yield data for miscellaneous crops. Provincial results indicate that agricultural production would increase significantly if summerfallow is reduced from current levels. The Dark Brown and Brown soil zones, having the greatest opportunity for fallow reduction, show the largest production increases.

Table 4.6.3

INCREASE IN PRODUCTION -

SUMMERFALLOW REDUCTION[1]

(Millions of Bushels)

Soil Zone	Wheat	Oats	Barley	Canola	Hay (Millions of tons)
Black	1.92	1.23	0.95	0.44	0.066
Dark Brown	6.37	1.12	4.72	0.56	0.042
Brown	5.97	0.47	1.48	0.008	0.023
Gray (Central)	0.079	0.19	0.37	0.016	0.019
Gray (Peace)	1.02	0.44	2.10	0.38	0.048
PROVINCIAL TOTAL	15.36	3.45	9.62	1.41	0.20
VALUE OF PRODUCTION (Millions of Dollars)	77.10	5.93	26.94	11.08	16.35

1. Based on a crop mix that includes projected (1990's) summerfallow acreages.

The long-term problems of soil degradation far outweigh any short-term benefits derived from summerfallowing. Additional benefits from decreasing summerfallow rates include the reduction of ground-water recharge and dryland salinization. Unfortunately, the quota system, based on cultivated area, rather than cropped area, encourages fallowing. Use of minimum or zero-tillage equipment is recommended to reduce erosion hazards on lands which must be summerfallowed. A reduction in summerfallow acreage would greatly increase current crop production as well as preserve the long-term productivity of the land through better soil conservation practices. A reduction of summerfallow acreage in Alberta could result in an estimated net increase in production of $137 million.

4.7 Range Improvement

4.7.1 Introduction

The rangelands of Alberta have always played a major role in maintaining beef cattle herds. The substantial increase in cattle since the 1950s and increased cost of feed grains have increased demand for grazing resources. Improvement of rangelands by the seeding of more productive tame species offers ranchers an opportunity to increase their production without expanding their grazing land base. Native range improvement is defined as breaking and seeding prairie range to tame pasture, and clearing, breaking and seeding of woodland range to tame pasture, which includes the use of fertilizers and fencing. Only CLI Class 5 lands in the White Area are considered for Range Improvement. The Prairie and Woodland range improvement suboptions will be examined separately.

In Alberta, native range can be separated into two major vegetative zones: prairie range for southern Alberta and woodland range found in central and northern Alberta. It is recognized that the line between these represents the gradual transition between the short, mixed and fescue grasslands of the prairie range to the parkland and boreal forests of the woodland range. Four major soil zones, grouped according to the following rangeland designations were analyzed:

PRAIRIE RANGELAND	WOODLAND RANGE
Brown	Black
Dark Brown	Gray (Central)
Black	Gray (Peace)

The southern portion of the Black soil zone is included in the prairie range because fescue grasslands are the dominant vegetation.

4.7.2 Area Estimate

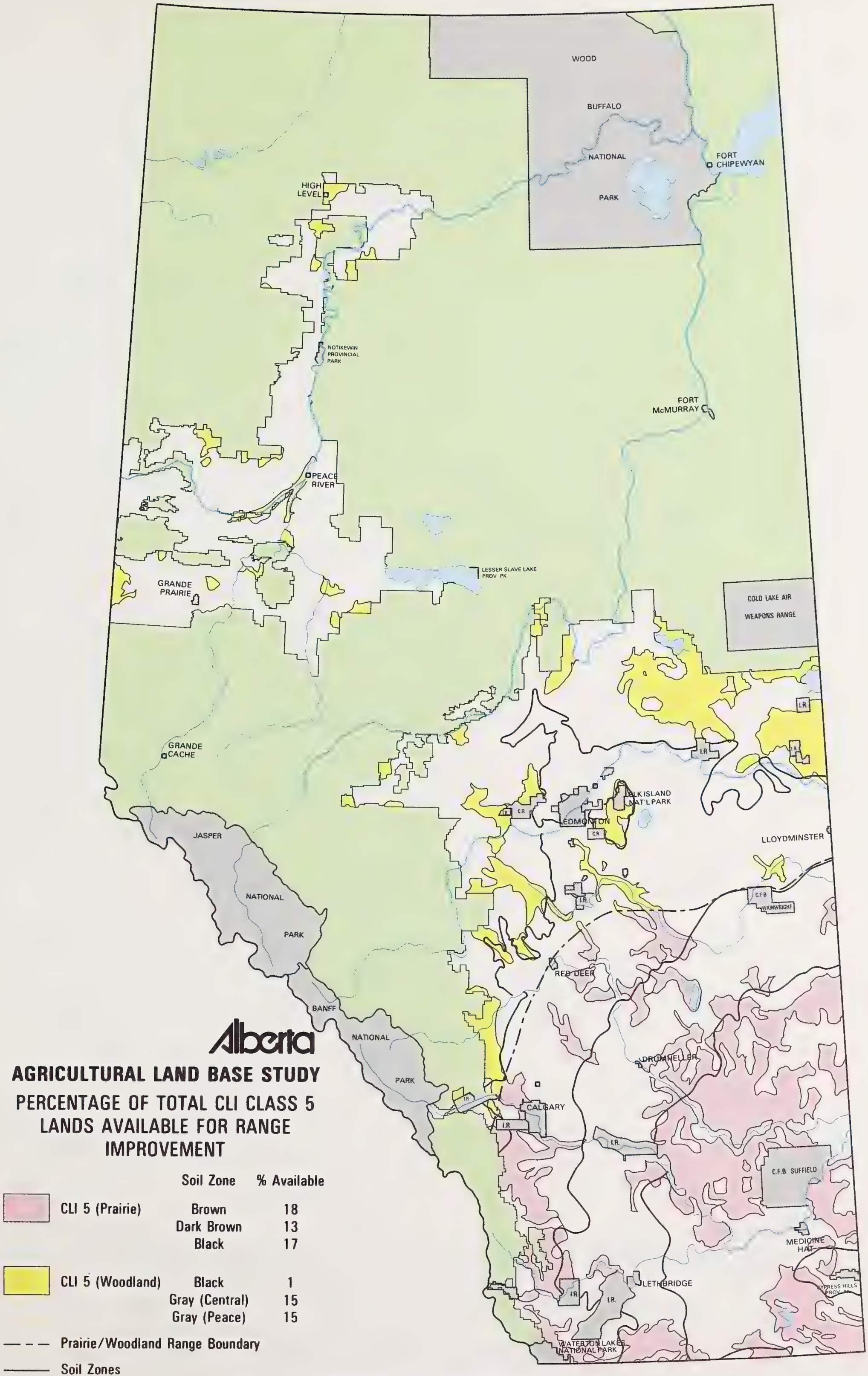
For the purposes of this study, lands considered suitable for range improvement include only Canada Land Inventory (CLI) Class 5 lands located in the White Area of the province. There are 11 million acres of CLI Class 5 lands in the White Area. Improvable acreage was calculated by subtracting 1981 Census of Agriculture improved pasture acreage from total CLI Class 5 lands. This acreage was further refined using development potentials from the Public Lands Division. Table 4.7.1 summarizes the acreage available for Prairie and Woodland Range Improvement. Development potentials indicate the physical potential for range improvement of existing unimproved CLI Class 5 land. Some Class 5 lands may not be suitable for range improvement due to solonetzic soils, acidity or salinity problems. Other factors such as Fish and Wildlife buffer zones and access problems have not been considered constraints to the potential development. In all soil zones except the Brown, 25 percent of all unimproved Class 5 lands have a physical potential for improvement. The Brown Soil Zone has a development potential of only 20 percent. (Personal communication Public Lands Division, AFLW). Figure 4.7.1 shows the location and distribution of CLI Class 5 lands in the province.

Table 4.7.1
ACREAGE AVAILABLE FOR RANGE IMPROVEMENT
(Millions of Acres)

PRAIRIE RANGE		WOODLAND RANGE	
Brown	0.76(18%)*	Black	0.013(1%)
Dark Brown	0.13(13%)	Gray (Central)	0.26(15%)
Black	0.15(17%)	Gray (Peace)	0.10(15%)
Subtotal =	1.04	Subtotal =	0.37
TOTAL = (Prairie and Woodland Range) = 1.41			

* % of total White Area CLI class 5 acreage per soil zone.

Sources:
1. Soil Capability for Agriculture, A Summary and Application of Canada Land Inventory Data in Alberta. Forestry, Lands and Wildlife 1983.
2. Alberta Census of Agriculture 1981 (Alberta Agriculture).
3. Personal Communication, Public Lands Division , April 1985.



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AGRICULTURAL LAND BASE STUDY

PERCENTAGE OF TOTAL CLI CLASS 5 LANDS AVAILABLE FOR RANGE IMPROVEMENT

		Soil Zone	% Available
🟪	CLI 5 (Prairie)	Brown	18
		Dark Brown	13
		Black	17
🟨	CLI 5 (Woodland)	Black	1
		Gray (Central)	15
		Gray (Peace)	15

– – – Prairie/Woodland Range Boundary

—— Soil Zones

SOURCE: LAND USE BRANCH, ALBERTA AGRICULTURE, 1985.

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA ENERGY AND NATURAL RESOURCES, 1985.

CLI Class 5 lands that have soil problems such as salinity, acidity and a solonetzic hardpan have been deleted. This map illustrates the areas considered physically capable of range improvement. Mapping information regarding current levels of improvement are not available.

4.7.3 Yield Estimates

Increases in agricultural production achieved through range improvement are expressed as increases in carrying capacity. Carrying capacity is defined as the maximum stocking rate possible without inducing damage to vegetation or related resources and is reported as animal unit months per acre. An animal unit is a mature 1 000 pound cow with calf or equivalent, based upon average consumption of 26 lbs. of organic matter per day. The forage required to support one animal unit for one month is defined as an animal unit month (AUM).

Increased carrying capacities due to improvement are presented in Tables 4.7.2 and 4.7.3 for prairie and woodland ranges respectively. In any one soil zone there is a range of carrying capacities which can be achieved on both unimproved and improved rangeland. This variability is a function of soil limitations, climate, system of management and range conditions. All carrying capacities presented in the tables reflect an average of this range.

Table 4.7.2
AVERAGE CARRYING CAPACITIES ON PRAIRIE RANGE
(Animal Unit Months per Acre)

SOIL ZONES	CARRYING CAPACITY ON UNIMPROVED RANGE	CARRYING CAPACITY ON IMPROVED PASTURE	INCREASE IN AUMs/ACRE
Brown	0.20	0.40	0.20
Dark Brown	0.35	1.05	0.70
Black	0.50	1.50	1.00

Sources:
1. Personal Communication with R.A. Wroe (Field Crops Branch, Alberta Agriculture, April, 1985.
2. Personal Communication with Public Lands Division, April, 1985.
3. Personal Communication with Canada Department of Agriculture, Lethbridge, April, 1985.

Table 4.7.3

AVERAGE CARRYING CAPACITIES ON WOODLAND RANGE

(Animal Unit Months per Acre)

SOIL ZONES	CARRYING CAPACITY ON UNIMPROVED RANGE	CARRYING CAPACITY ON IMPROVED PASTURE[1]	INCREASE IN AUMs/ACRE
Black	0.25	2.0	1.75
Gray (Central)	0.20	2.0	1.80
Gray (Peace)	0.20	2.0	1.80

[1] Includes fencing and fertilizer improvements and brush control.

Sources: 1. Personal Communication with R.A. Wroe (Field Crops Branch, Alberta Agriculture, April, 1985.
2. Personal Communication with Public Lands Division, April, 1985.
3. Personal Communication with Canada Department of Agriculture, Lethbridge, April, 1985.

For example, improved woodland pasture in the Black and Gray soil zones under an extensive management system would have carrying capacities close to 1.0 AUM per acre. A more intensive management system in the same area would see carrying capacities closer to 3.0 AUM per acre. The 2.0 AUM per acre is used in the study as a realistic average for those soil zones.

4.7.4 Summary

Table 4.7.4 shows the increase in agricultural production for the province and for regions if rangelands are improved. Results indicate that an additional 1.1 million animal unit months of grazing may be available in the province if rangelands are improved. Woodland range has almost twice the increase in production compared to prairie range. Although a much larger number of acres are available for improvement in the prairie range, the greater increase in carrying capacity for improved woodland range contributes more to increased production. Range improvement could result in an estimated net increase in production of $50 million.

Table 4.7.4

INCREASE IN PRODUCTION -

RANGE IMPROVEMENT

(Millions of Animal Unit Months)

Soil Zone	Before Improvement	After Improvement	Increase in Production
Prairie Range			
Brown	0.15	0.30	0.15
Dark Brown	0.047	0.14	0.093
Black	0.074	0.22	0.15
Sub Total	0.27	0.66	0.39
Woodland Range			
Black	0.003	0.027	0.023
Gray (Central)	0.053	0.53	0.48
Gray (Peace)	0.020	0.20	0.18
Sub Total	0.076	0.76	0.68
PROVINCIAL TOTAL	0.35	1.42	1.07
VALUE OF PRODUCTION* (Millions of Dollars)	16.21	65.75	49.54

* Livestock prices are a gross value based on an average gain for feeders of 65.58 lbs. over 5 months of summer grazing at a price of $.706 per lb. The winter cow herd maintenance cost is taken into account in the economic report (through costing yearlings at the market price) in deriving a net value per AUM. (1 AUM = $46.30)

4.8 Prairie Range Conversion

4.8.1 Introduction

Rangeland accounts for a significant portion of Alberta's agricultural land base. This land has been extensively utilized as a grazing resource by domestic livestock. However, in areas of the province that have the capability to produce cash crops, there has been a continuing trend to expand crop production. Range Conversion is defined as the breaking and seeding of CLI Class 1-4 prairie range to cultivated cash crops in the White Area.

In Alberta, prairie rangeland is found in the southern portion of the province, and includes the short grass, mixed grass and fescue grass ecoregions. The line separating rangeland from woodland is not as distinct as indicated on the map but represents the gradual transition between the two categories. It is consistent with the Range Improvement management option. Three major soil zones associated with rangeland in the province were analyzed: Brown, Dark Brown and the southwest portion of the Black Soil Zone.

4.8.2 Area Estimate

The area considered for range conversion includes CLI Class 1-4 lands located in the southern portion of the province minus the acreage of "excluded areas" and the area that is currently in cultivation (1981 Census). Cultivated land includes crops, summerfallow and other improved lands. To produce a map illustrating areas suitable for range conversion, Landsat images were examined to identify cultivated and non-cultivated land. Table 4.8.1 documents acreage estimates, broken down by soil zones, while Figure 4.8.1 shows their location.

All area calculations are made using the information in Table 4.8.1. Figure 4.8.1 is presented only to show the area under discussion.

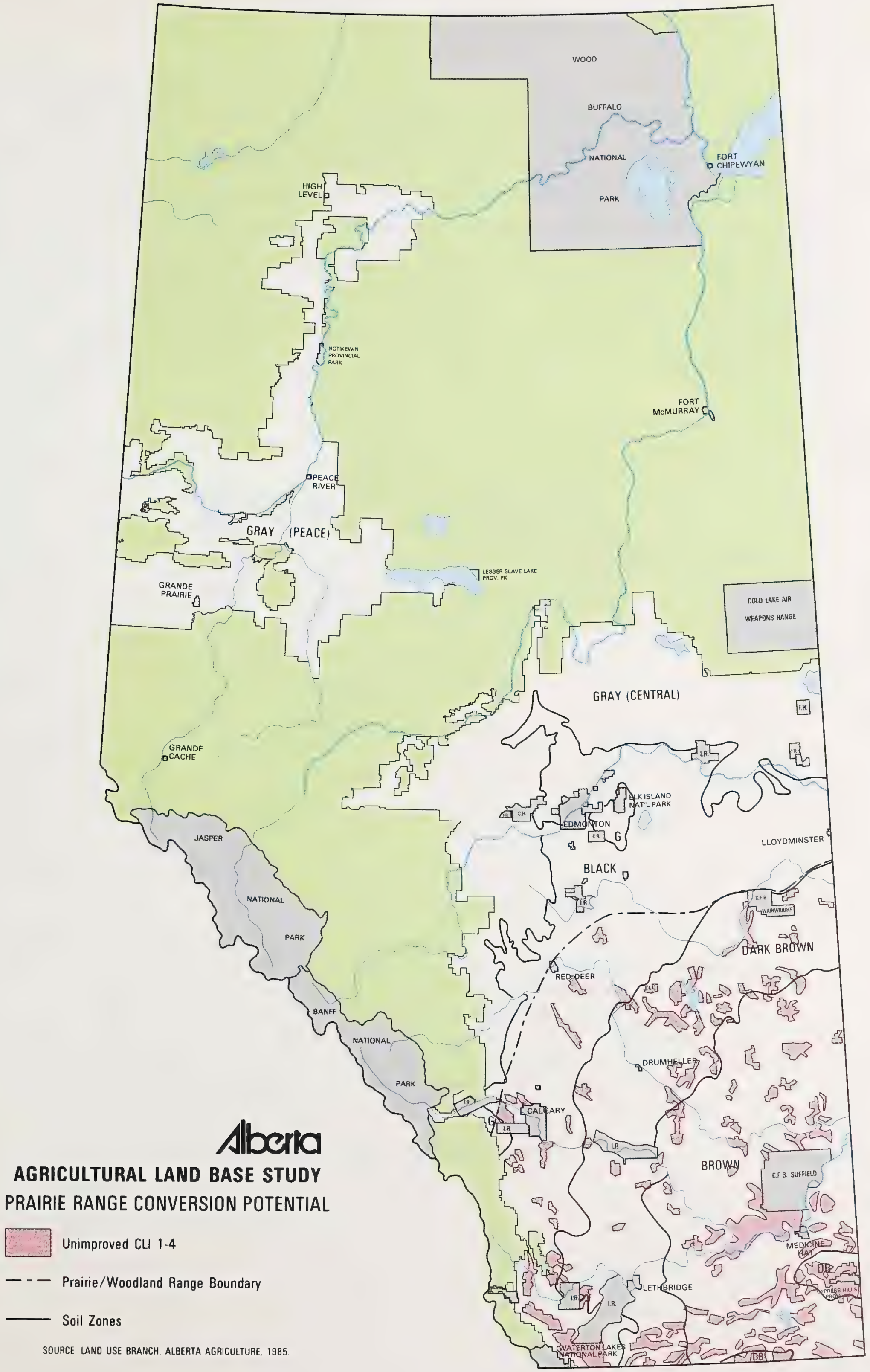
Table 4.8.1

PRAIRIE RANGE CONVERSION ACREAGE ESTIMATES

(Millions of Acres)

Soil Zone	CLI 1-4[1]	Currently Cultivated[2]	Acres Available[3]	Refined Acres Available
Black	2.83	2.16	0.67	0.64
Dark Brown	6.11	5.17	0.94	0.89
Brown	6.24	4.14	2.10	2.00
Provincial Total	15.18	11.47	3.71	3.53

1. Adapted from the Canadian Geographic Information System "Canada Land Inventory for Agriculture Data by Alberta Administrative Units". Published in "Soil Capability for Agriculture: A Summary and Application of Canada Land Inventory in Alberta" 1983 AFLW Technical Report Number T/45. "Excluded areas" have been subtracted from the acreage.
2. Source: 1981 Census information. Includes: crops, summerfallow and other categories.
3. Based on: Acreage of CLI Classes 1-4 minus 1981 Census information on currently cultivated land.
4. A 5 percent reduction was also made based on Public Lands information. This represents land that does not have a physical suitability for agricultural expansion.



Alberta

AGRICULTURAL LAND BASE STUDY

PRAIRIE RANGE CONVERSION POTENTIAL

SOURCE: LAND USE BRANCH, ALBERTA AGRICULTURE, 1985.

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA ENERGY AND NATURAL RESOURCES, 1985.

4.8.3 Yield Estimate

In agricultural production can be increased by converting range to cultivated crops. Before conversion, crop production is assumed to be zero. The agricultural capability rating of this land is predominantly CLI classes 3 and 4 rather than 1 and 2. It was assumed that these lands are primarily CLI class 4 and that CLI Class 1-3 lands have been fully developed. This reflects a distribution of undeveloped CLI classes similar to the Green Area. Therefore, potential crop yield estimates by soil zone were lower. Table 4.8.2 shows the revised productivity figures.

Table 4.8.2
INCREASE IN CROP PRODUCTION AFTER
CONVERSION OF PRAIRIE RANGELANDS

Soil Zone	Wheat	Oats	Barley	Canola	Hay (Tons per Acre)
	(Bushels per Acre)				
Black	24.7	44.5	34.5	15.9	1.5
Dark Brown	23.1	42.4	35.9	17.2	1.0
Brown	18.6	29.4	31.1	12.7	0.6
Average Provincial Increase	22.1	38.8	33.8	15.3	1.0

Source(s): Environment Council of Alberta, 1984.
Maintaining and Expanding the Agricultural Land Base in Alberta: Summary Report and Recommendations.
Lands Directorate - CLI acreages by municipality.

Note: It is assumed that the distribution of CLI classes on currently uncultivated lands in the Central and Peace River areas is similar to that in the Green area (CLI Class 1(0%), Class 2(.5%), Class 3(9.2%), Class 4(89.3%)).
Hay yields have not been refined.

4.8.4 Summary

The inventory results indicate a potential for considerably increasing agricultural production through prairie range conversion. Table 4.8.3 shows this potential increase in specific regions and for the whole province. This increase in annual crop production, however, could reduce unimproved grazing in southern Alberta by 1.03 million AUMs ($47.69 million).

Table 4.8.3

INCREASE IN PRODUCTION[1] - PRAIRIE RANGE CONVERSION

Soil Zone	Wheat	Oats	Barley	Canola	Hay (Millions of Tons)	Value of Prod. (Millions of Dollars)
	(Millions of Bushels)					
Black	3.48	2.09	8.32	0.75	0.16	60.34
Dark Brown	8.47	1.20	6.07	0.65	0.07	72.99
Brown	16.80	1.23	3.92	0.13	0.09	105.82
Provincial Total	28.75	4.52	18.31	1.53	0.32	239.15

1. Based on a crop mix that includes current 1981 summerfallow acreages.

Lands which have been highly susceptible to erosion in the past should be carefully examined before recultivation. Wind erosion will probably affect the same region over time, and soils in these areas are sensitive to erosion damage. Practices such as wind breaks, adequate trash cover, strip cropping and lower tillage speeds reduce a soil's susceptibility to erosion. Careful management of these sandy Brown Soils is required to convert lands currently used as a range resource. Rangeland Conversion to cropland could result in an estimated net increase in production of $191 million (See Table 4.8.4).

Table 4.8.4

NET INCREASE IN VALUE OF PRODUCTION
PRAIRIE RANGE CONVERSION

(Millions of Dollars)

Soil Zone	Gross Value of Production Increases	Gross Value of Lost Unimproved Grazing	Net Value of Production Increases
Black	60.34	8.58	51.76
Dark Brown	72.99	11.92	61.07
Brown	105.82	27.18	78.64
Total	239.15	47.69	191.46

4.9 Woodland Conversion

4.9.1 Introduction

The conversion of woodlands to croplands is restricted to the central and northern regions of the White Area. Some of these woodland areas are capable of producing cash crops. A trend to expand agricultural production continues through woodland conversion, and through the clearing, breaking and seeding of CLI Class 1-4 woodland areas to cultivated cash crops.

Woodland vegetation covers a large portion of Alberta. Woodlands found in the central and northern regions, include the aspen parkland and boreal forest ecoregions. The division between woodland and rangeland is not always distinct but the line on the map is representative of the gradual transition between these two categories. It is consistent with the line used in Range Improvement and Range Conversion management options. The analysis for this management option was completed by soil zones. Three major soil zones associated with woodland conversion were analyzed: Gray (Peace) Gray (Central) and the northern portion of the Black Soil Zone.

4.9.2 Area Estimates

The initial area considered for range conversion included CLI Class 1-4 lands in the central and northern portion of the province. The acreage of "excluded areas" was subtracted from this initial acreage, as was the area that is currently in cultivation (1981 Census). Cultivated land includes crops, summerfallow and other improved lands. An additional 15 percent reduction was made, based on Public Lands Division information. This percentage represents land that is not suitable for agricultural expansion due to local physical landscape conditions or isolation. To produce a map illustrating areas suitable for woodland conversion, Landsat images were examined to identify cultivated and non-cultivated land. Table 4.9.1 documents the acreage estimates by soil zones. Figure 4.9.1 shows the area that has a potential for woodland conversion. Production calculations are made using the information in Table 4.9.1. Figure 4.9.1 shows the area under consideration.

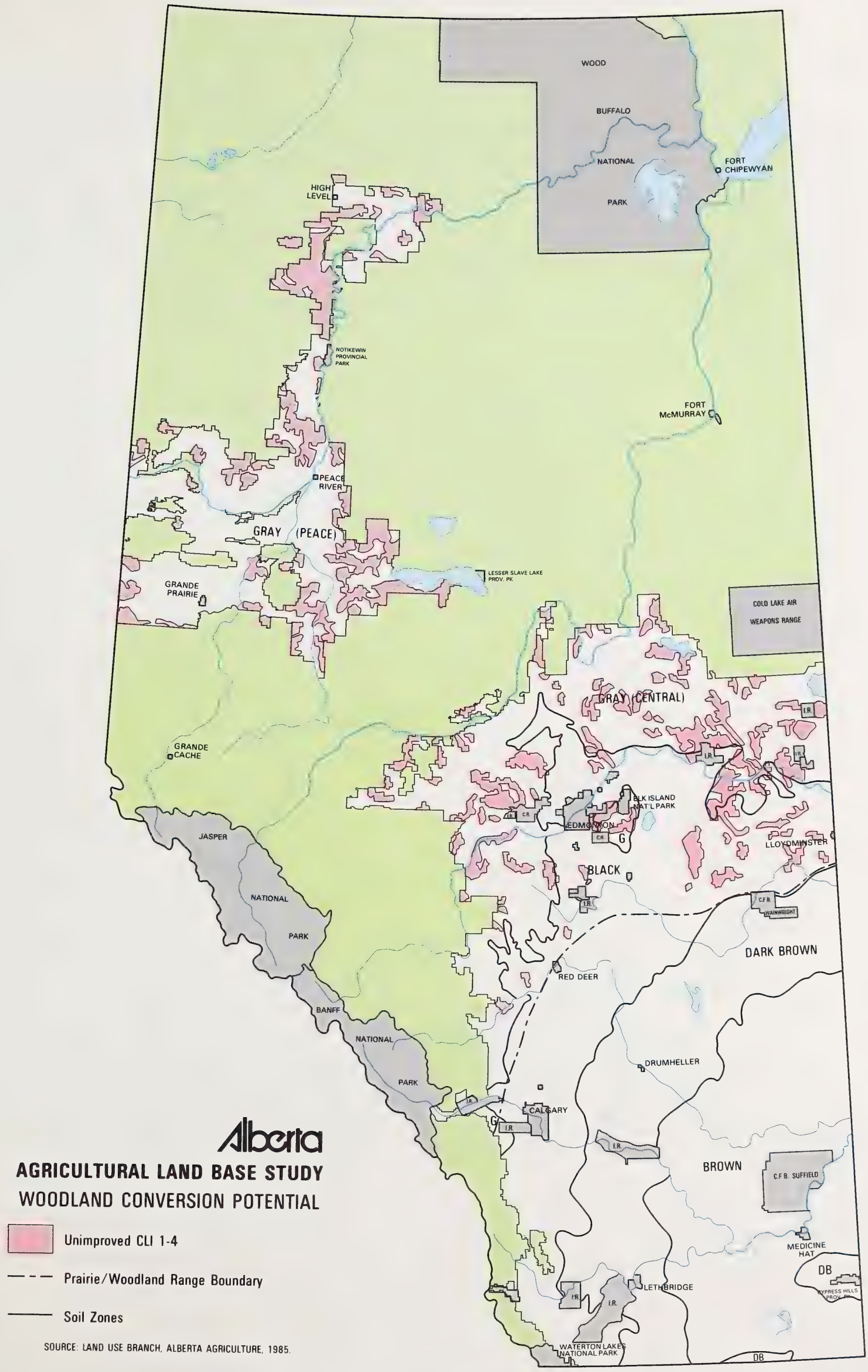
Table 4.9.1

WOODLAND CONVERSION ACREAGE ESTIMATES

(Millions of Acres)

Soil Zone	CLI 1-4[1]	Currently Cultivated[2]	Initial Acres Available[3]	Refined Acres Available[4]
Black	10.34	7.82	2.50	2.13
Gray (Central)	4.89	2.77	2.12	1.80
Gray (Peace)	7.64	3.95	3.69	3.14
Provincial Total	22.87	14.55	8.31	7.07

1. Adapted from the Canadian Geographic Information System (Canada Land Inventory for Agricultural Data by Alberta Administrative Units." Published in "Soil Capability for Agriculture: A Summary and Application of Canada Land Inventory in Alberta" 1983 AFLW Technical Report #T/45. "Excluded areas" have been subtracted from the acreage.
2. Source: 1981 Census information. Includes: crop, summerfallow and other acreages.
3. Based on: Acreage of CLI classes 1-4 minus 1981 Census information on currently cultivated land.
4. A 15 percent reduction was also made, based on Public Lands Division information. This percentage represents land that is not suitable for agricultural expansion.



Alberta

AGRICULTURAL LAND BASE STUDY

WOODLAND CONVERSION POTENTIAL

🟥 Unimproved CLI 1-4

– – Prairie/Woodland Range Boundary

— Soil Zones

SOURCE: LAND USE BRANCH, ALBERTA AGRICULTURE, 1985.

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA ENERGY AND NATURAL RESOURCES, 1985.

4.9.3 Yield Increment

Agricultural productivity can be increased by converting woodlands to cultivated crops. Before conversion, crop production is assumed to be zero. The agricultural capability rating of this land is predominantly CLI Classes 3 and 4 rather than 1 and 2. Yields were therefore adjusted down to reflect this distribution of CLI classes. Table 4.9.2 shows these initially revised productivity figures.

Table 4.9.2

INCREASE IN CROP PRODUCTION AFTER WOODLAND CONVERSION

Soil Zone		Wheat	Oats	Barley	Canola	Hay
		(Bushels per Acre)				(Tons per Acre)
Black	Yield on converted woodland range	24.7	44.5	34.5	15.9	1.5
Gray (Central)	Yield on converted woodland range	24.6	43.6	31.1	9.6	1.7
Gray (Peace)	Yield on converted woodland range	23.5	43.9	30.3	13.0	1.6

Source(s): Environment Council of Alberta, 1984.
Maintaining and Expanding the Agricultural Land Base in Alberta: Summary Report and Recommendations.
Lands Directorate - CLI acreages by municipality.

Note: It is assumed that the distribution of CLI classes on currently uncultivated lands in the Central and Peace River areas is similar to the Green area (CLI Class 1(0%), Class 2(.5%), Class 3(9.2%), Class 4(89.3%)).
Hay yields have not been refined.

4.9.4 Summary

The inventory results indicate a potential for considerably increasing agricultural production through woodland range conversion. Table 4.9.3 shows this potential increase both in specific regions and for the whole province. The increased crop production resulting from woodland conversion, however, reduces unimproved grazing by 1.52 million AUMs ($70.38 million). A shorter growing season and susceptibility to water erosion are two of the major constraints to this development alternative. Higher value grain crops require longer frost-free periods to reach maturity, and the rainfall, topography, and silty texture of the Peace River Gray soil zone make these lands very susceptible to erosion. Woodland Conversion to cropland could result in an estimated net increase in agricultural production of $568 million (Table 4.9.4).

Table 4.9.3

INCREASE IN PRODUCTION - WOODLAND CONVERSION

Soil Zone	Wheat	Oats	Barley	Canola	Hay	Value of Prod.
	(Millions of Bushels)				(Millions of Tons)	(Millions of Dollars)
Black	11.04	6.63	26.45	2.37	0.5	200.38
Gray (Central)	3.54	7.85	16.23	0.52	1.19	178.07
Gray (Peace)	13.28	5.51	28.57	0.52	0.80	260.05
PROVINCIAL TOTAL	27.86	19.99	71.25	4.90	0.80	638.50

1. Based on a crop mix that includes current 1981 summerfallow acreages.

Table 4.9.4

NET INCREASE IN VALUE OF PRODUCTION

WOODLAND CONVERSION

(Millions of Dollars)

Soil Zone	Gross Value of Production Increases	Gross Value of Lost Unimproved Grazing	Net Value of Production Increases
Black	200.38	21.11	179.27
Gray (Central)	178.07	17.60	160.47
Gray (Peace)	260.05	31.67	228.38
Total	638.50	70.38	568.12

4.10 Saline Soil Reclamation

4.10.1 Introduction

Soil salinity is a major problem on the western prairies. Saline seepage includes all processes by which soluble salts accumulate at or near the soil surface. Saline seeps occur naturally in parts of Alberta, however, man's activities have aggravated the problem and have created new salinization problems. Practices such as summerfallow, irrigation, annual cropping, deforestation and over-grazing are responsible for the increased development of saline seeps.

A number of management practices can be applied to control saline seepage. These include:

1) preventing the formation and deep percolation of excess moisture in the recharge area through:
    a) recropping
    b) growing deep-rooted perennial crops;
2) surface drainage of saline seeps;
3) use of salt tolerant crops in the seepage area;
4) irrigation and subsurface drainage to leach salts out of the rooting zone;
5) lining of irrigation canals.

Table 4.10.1
ACREAGE OF SALINE SOILS IN ALBERTA
(Millions of acres)

Total Saline[1] Acreage	Refined Saline Acreage[2]	Dryland Salinity Acreage[3]	Irrigated Salinity Acreage
3.21	2.47	2.22	0.25

1. Source: T.G. Sommerfeldt, 1984. Dryland Salinity Mapping for Alberta south of Township 36 between the 4th and 5th meridian. This number also includes an additional .74 million acres estimated to occur in the remainder of the province (H. Vander Pluym, personal communication).
2. Excludes areas of CLI Class 5+ and lands excluded from the study.
3. Includes lands outside the irrigation districts as well as lands within the irrigation districts which are not currently irrigated.

4.10.2 Area Estimates

Approximately 3.2 million acres of land in Alberta are affected to some extent by soil salinity. That this acreage is expanding is also of concern.

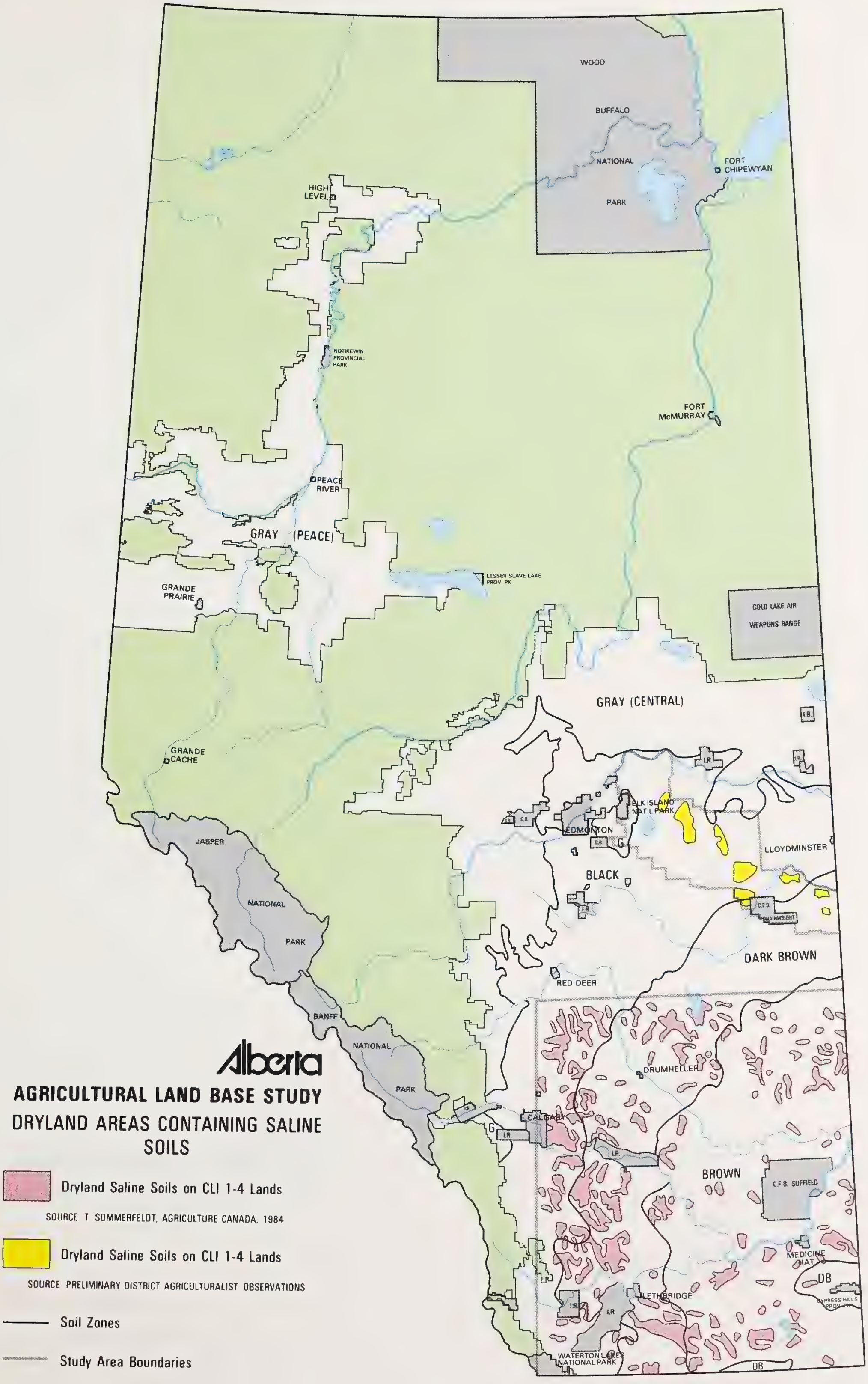
The above estimate of acreage was calculated from the results of a study by T. Sommerfeldt (1984) and from information received from local district agriculturists. The 3.2 million acres affected include lands that range from the slightly saline that would not affect crop yield to the salt-crust areas where crop growth has been eliminated. Table 4.10.1 shows the total and refined acreage of saline soil in the province. Tables 4.10.2 and 4.10.3 show the distribution of dryland and irrigated saline soils by soil zone and irrigation climatic zone. Figures 4.10.1 and 4.10.2 show where salinity occurs.

4.10.3 Yield Estimates

The reduced productivity on saline soils is related to salinity and waterlogging. Soil salinity not only reduces or eliminates crop production but, by isolating good parcels of land, the seeps further reduce. Soil salinity also reduces the prospective range of available crops. For example, barley has a higher salt tolerance than oats.

Research results have shown that the productivity of most crops varies according to the severity of salinization. Since levels of salinity could not be determined by this scale of study, an overall yield reduction of 25 percent on dryland and 50 percent on irrigated land would be most representative. Tables 4.10.4 and 4.10.5 show the average crop yields on saline soil.

It is assumed that under correct management, yields on these lands can be returned to benchmark. It is important to note that due to physical limitations, a portion of this land will be uneconomical to reclaim. However, barring economic constraints, it is assumed that 100 percent of the saline land base can be reclaimed.



Alberta

AGRICULTURAL LAND BASE STUDY

DRYLAND AREAS CONTAINING SALINE SOILS

🟥 Dryland Saline Soils on CLI 1-4 Lands

SOURCE T SOMMERFELDT, AGRICULTURE CANADA, 1984

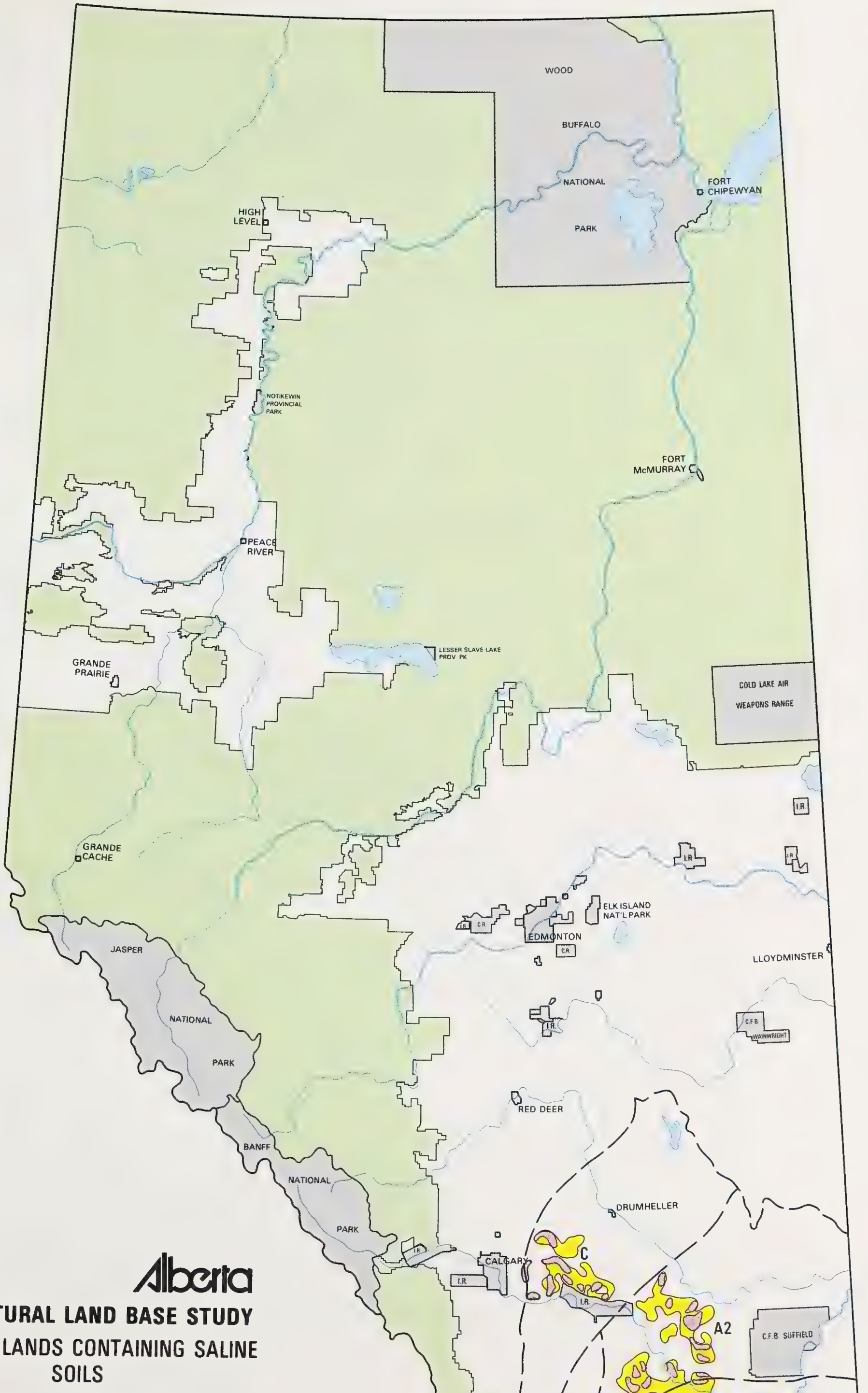
🟨 Dryland Saline Soils on CLI 1-4 Lands

SOURCE PRELIMINARY DISTRICT AGRICULTURALIST OBSERVATIONS

— Soil Zones

— Study Area Boundaries

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA ENERGY AND NATURAL RESOURCES, 1985.



Alberta

AGRICULTURAL LAND BASE STUDY

IRRIGATED LANDS CONTAINING SALINE SOILS

🟨 Current Irrigation

▨ Saline Areas

— — Irrigation Climatic Zones

SOURCE: T. SOMMERFELDT, AGRICULTURE CANADA, 1984.

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA ENERGY AND NATURAL RESOURCES, 1985.

Table 4.10.2
DRYLAND SALINE SOILS IN ALBERTA
(Millions of Acres)

Soil Zone	Distribution	Acres
Black	(35%)	.78
Dark Brown	(31%)	.69
Brown	(28%)	.62
Gray (Central)	(5%)	.11
Gray (Peace)	(1%)	.02
Provincial Total	(100%)	2.22

TABLE 4.10.3
CURRENTLY IRRIGATED SALINE SOILS IN ALBERTA
(Millions of Acres)

Irrigation Climatic Zone*	Distribution	Acres
A1	(20%)	.05
A2	(55%)	.14
B	(5%)	.01
C	(20%)	.05
Provincial Total	(100%)	.25

* Brown soil zone (Irrigation Climatic Zones A1, A2) = .19 million acres.
Dark Brown soil zone (Irrigation Climatic Zones B, C) = .06 million acres.

Table 4.10.4

INCREASE IN CROP PRODUCTION ON DRYLAND AREAS AFTER RECLAMATION

(Bushels per Acre)

Soil Zone		Wheat	Oats bu/ac	Barley	Canola	Hay tons/ac
Black	Yield on saline soil[1]	26.5	47.3	36.6	16.9	1.13
	Yield on reclaimed soil[2]	35.3	63.0	48.8	22.5	1.5
	Productivity Increase	8.8	15.7	12.2	5.6	0.37
Dark Brown	Yield on saline soil	24.5	45.1	38.2	18.2	0.75
	Yield on reclaimed soil	32.7	60.1	50.9	24.3	1.0
	Productivity Increase	8.2	15.0	12.7	6.1	0.37
Brown	Yield on saline soil	19.8	31.2	33.1	13.5	0.45
	Yield on reclaimed soil	26.4	41.6	44.1	18.0	0.6
	Productivity Increase	6.6	10.4	11.0	4.5	0.15
Gray (Central)	Yield on saline soil	24.5	46.3	33.1	13.7	1.28
	Yield on reclaimed soil	32.7	61.7	44.1	18.3	1.7
	Productivity Increase	8.2	15.4	11.0	4.6	0.42
Gray (Peace)	Yield on saline soil	22.4	41.9	29.0	12.4	1.2
	Yield on reclaimed soil	29.9	55.8	38.6	16.5	1.6
	Productivity Increase	7.5	13.9	9.6	4.1	0.4

1. Determined as a 25 percent yield reduction from benchmark.
2. Benchmark yield.

Table 4.10.5

INCREASE IN CROP PRODUCTION ON CURRENTLY IRRIGATED AREAS AFTER RECLAMATION

Irrigation Climatic Zone		Wheat	Oats	Barley	Canola	Hay
			(Bushels per Acre)			(Tons per Acre)
A1	Yield on saline soil[1]	43.1	47.9	47.9	23.0	1.6
	Yield on reclaimed soil[2]	86.3	95.9	95.9	46.1	3.1
	Productivity Increase	43.2	48.0	48.0	23.1	1.5
A2	Yield on saline soil	42.9	47.8	47.8	23.9	1.6
	Yield on reclaimed soil	85.8	95.7	95.7	47.9	3.1
	Productivity Increase	42.9	47.9	47.9	24.0	1.5
B	Yield on saline soil	44.7	48.3	48.3	23.9	1.5
	Yield on reclaimed soil	89.4	96.7	96.7	47.9	3.0
	Productivity Increase	44.7	48.4	48.4	24.0	1.5
C	Yield on saline soil	40.1	47.4	47.4	24.1	1.4
	Yield on reclaimed soil	80.3	94.8	94.8	48.2	2.8
	Productivity Increase	40.2	47.4	47.4	24.1	1.4

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1. Determined as a 50 percent yield reduction from benchmark.
2. Strong Hall and Associates, Marv Anderson and Associates Ltd. and Environmental Management Associates; South Saskatchewan River Basin Planning Program: Evaluation Methodologies and Data Base.

4.10.4 Summary

Soil salinity is a serious problem for many Alberta farmers. Tables 4.10.6 and 4.10.7 show the increase in crop production for specific regions and for the province as a whole after reclamation of saline soils. Controlling salinity is difficult because the actions of one individual impinge upon others. Often the management practices of one farm become the management problem of another. The two fundamental control techniques address either the recharge or discharge areas. Prevention or removal of the source (recharge area) is often the more desirable. Unless the farmer owns the discharge area, however, he may not be willing to change his management practices. The distance between recharge and discharge sites, and their ownership, are ongoing problems for the reclamation of currently salinized lands. Saline Soil Reclamation could result in an estimated net increase of $112 million: $59 and $53 million for irrigated and dryland salinity respectively.

Table 4.10.6

INCREASE IN PRODUCTION:

DRYLAND SALINE SOILS

Soil Zone	Wheat	Oats	Barley	Canola	Hay
	(Millions of Bushels)				(Millions of Tons)
Black	1.44	0.86	3.43	0.31	0.05
Dark Brown	2.15	0.31	1.58	0.17	0.01
Brown	1.76	0.13	0.48	0.01	0.01
Gray (Central)	0.07	0.19	0.35	0.01	0.02
Gray (Peace)	0.03	0.01	0.32	0.05	0.001
PROVINCIAL TOTAL	5.45	1.50	6.16	0.56	0.09
VALUE OF PRODUCTION (Millions of Dollars)	27.36	2.58	17.25	4.40	7.36

Based on a crop mix that includes current 1981 summerfallow acreages.

Table 4.10.7
INCREASE IN PRODUCTION: IRRIGATED SALINE SOILS

Irrigation-Climatic Zone	Wheat	Oats	Barley	Canola	Hay
		(Millions of Bushels)			(Millions of Tons)
A1	1.14	0.04	0.42	0.02	0.04
A2	3.18	0.11	1.17	0.05	0.11
B	0.24	0.01	0.08	0.00	0.01
C	1.06	0.04	0.41	0.17	0.04
PROVINCIAL TOTAL	5.62	0.20	2.08	0.24	0.20
VALUE OF PRODUCTION (Millions of Dollars)	28.21	0.34	5.82	1.89	16.35

Based on a crop mix that includes 1983 summerfallow acreages.

SUMMARY 5.0

Alberta's agricultural land base can be expanded into new areas, and its productivity can be increased by various land and water management techniques. The Agricultural Inventory was undertaken to estimate the location, area, and increases in agricultural production resulting from the full implementation of ten development alternatives. Initial estimates were made on the basis of published stastical data. Final or refined estimates were made by various resource specialists and took into account agricultural capability, current agricultural use, regional variations in productivity and current management practices. Area and production estimates are presented as millions of acres and dollars respectively. Presentation of production estimates by gross annual dollar values standardizes basic differences inherent in the original units of measurement: weight (tons/acre), volume (bushels/acre) and grazing capacity (animal units/month). A third set of derived statistics, based on a ratio of the dollar value of production per acre, have also been included. The Inventory provides a comprehensive comparative analysis of each development alternative's potential for increasing agricultural production in Alberta.

A provincial summary of the Inventory's results are presented in Table 5.1. A total of 33 million acres were identified as being suitable for agricultural expansion or intensification. The total Inventory acreage represents an area equivalent to Alberta's currently improved land base of 30 million acres, as defined by the 1981 Census of Agriculture. Full implementation of the identified acreage for all ten development alternatives would result in a total increase in production valued at $2.5 billion annually. The total Inventory production estimates represent a 65 percent increase in Alberta's 1984 Annual Farm Cash Receipts of $3.9 billion. The derived provincial average value of production per acre, resulting from the full implementation of all development alternatives, was estimated to equal $75. The total value of production calculations represent a gross dollar estimate based solely on the value of agricultural production realized from full implementation.

These calculations do not consider economic effeciencies nor the relative costs of implementation to the farmer or society. These analyses were undertaken in separate Agricultural Land Base Study technical reports.

Individually, the ten development alternatives represent significant opportunities for increasing agricultural production. Each alternative affects more than 1 million acres and generates a corresponding increase in production valued in excess of $50 million annually. However, individual development alternatives exhibit a wide degree of variability in both acreages available for development and their corresponding potential increases in production. Acreage estimates range from a low of

Table 5.1

INCREASES IN ANNUAL AGRICULTURAL PRODUCTION BY DEVELOPMENT ALTERNATIVES*

DEVELOPMENT ALTERNATIVES	TOTAL VALUE OF PRODUCTION ($ MILLION)	POTENTIAL AREA (MILLION ACRES)	VALUE OF PRODUCTION ($/ACRE)
1. Green Area Conversion	762	9.20	82.83
2. Irrigation Expansion	306	1.14	268.42
3. Drainage	241	2.12	113.68
4. Deep Plowing	83	2.22	37.39
5. Liming	50	2.61	19.16
6. Summerfallow Reduction	137	1.37	100.00
7. Range Improvement			
-Prairie	18	1.04	17.31
-Woodland	31	0.37	83.78
8. Prairie Range Conversion	191	3.53	54.11
9. Woodland Conversion	568	7.07	80.34
10. Saline Soil Reclamation			
-Dryland	59	2.22	26.44
-Irrigated	53	0.25	212.40
PROVINCIAL TOTALS	2499	33.14	75.41

*Area overlaps and double counting are avoided wherever possible.

1.1 million acres for Irrigation Expansion to a high of 9.2 million acres for Green Area Conversion. The average acreage estimate is approximately 3.3 million acres. Production estimates range from a low of $50 million for Liming and Range Improvement (Prairie and Woodland) to a high of $762 million annually for Green Area Conversion. The average production estimates are valued at $250 million annually. The value of production per acre estimates also show considerable variability; ranging from a low of less than $20 per acre for Prairie Range Improvement and Liming to a high of more than $200 per acre for the Irrigated-Saline Soil Reclamation and Irrigation Expansion.

The relative magnitude of each alternative's contribution to future agricultural development can be examined collectively, by classifying each according to their designation as expansion or intensification alternatives. For the purposes of this study, expansion alternatives were defined as options characterised by the cultivation of new undeveloped CLI class 1-4 lands for field crop production. Development alternatives not meeting this primary criteria are classified as intensification opportunities. Intensification alternatives are characterized by an increased level of production on lands currently or previously under cultivation, or in the case of range improvement lands allocated for grazing at less than optimal levels. Of the ten development alternatives examined in the Agricultural Land Base Study, four are classified as expansion opportunities and six intensification:

Expansion Alternatives

- Green Area Conversion
- Drainage
- Prairie Range Conversion
- Woodland Conversion

Intensification Alternatives

- Irrigation Expansion
- Deep Plowing
- Liming
- Summerfallow Reduction
- Range Improvement
    - -Prairie
    - -Woodland
- Saline Soil Reclamation
    - -Dryland
    - -Irrigation

The cumulative contributions of the grouped expansion or intensification opportunities, as well as the variability among individual development alternatives are illustrated in Figures 5.1 and 5.2. Although there is a greater number of intensification opportunities, each of the expansion alternatives makes a comparatively greater contribution to the provincial total. In Alberta, expansion alternatives contribute 65-70 percent of the total acreage and gross annual value of production achievable with full implementation. The 22 million acres and $1760 million identified for expansion represents two-thirds of the total provincial development potential. The total expansion opportunity is evenly distributed between the provincial Green and White Areas, as Green Area Conversion represents approximately 42 percent of the total expansion opportunity. The magnitude of these expansion opportunities indicate a resource of national significance. Alberta is recognized as having one of the last large blocks of undeveloped lands available for future agricultural expansion in Canada.

Intensification opportunities are significant from an Alberta perspective. The intensification opportunities, 11 million acres with annual production increases totalling $740 million, represent close to one-third of Alberta's development potential. Intensification opportunities are restricted to locations within the provincial White Area.

Provincially, the four expansion alternatives average 5.5 million acres, generate a corresponding production potential of $440 million annually and have an estimated value of production per acre totalling $80. Intensification alternatives average only 2 million acres, generate $120 million annually and have a production value per acre totalling $65. However the four expansion alternatives are closely comparable, revealing little variability between opportunities. The range of values among the different intensification opportunities show considerably more variation. This variability is emphasised in an examination of the production per acre estimates. Collectively the expansion alternatives have a larger average value of production per acre. Individually the intensification

Figure 5.1 Provincial Summary Total Value of Production

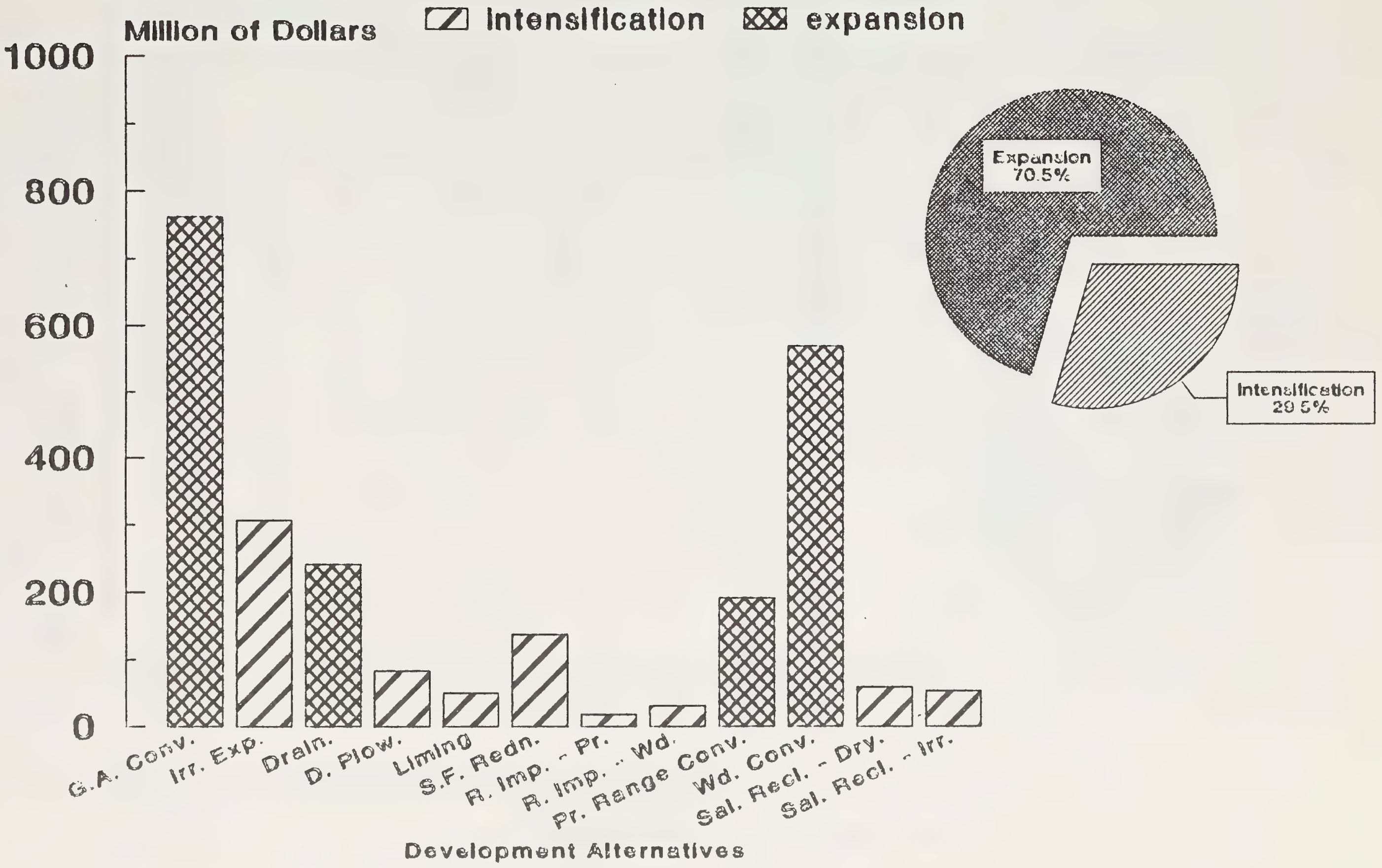
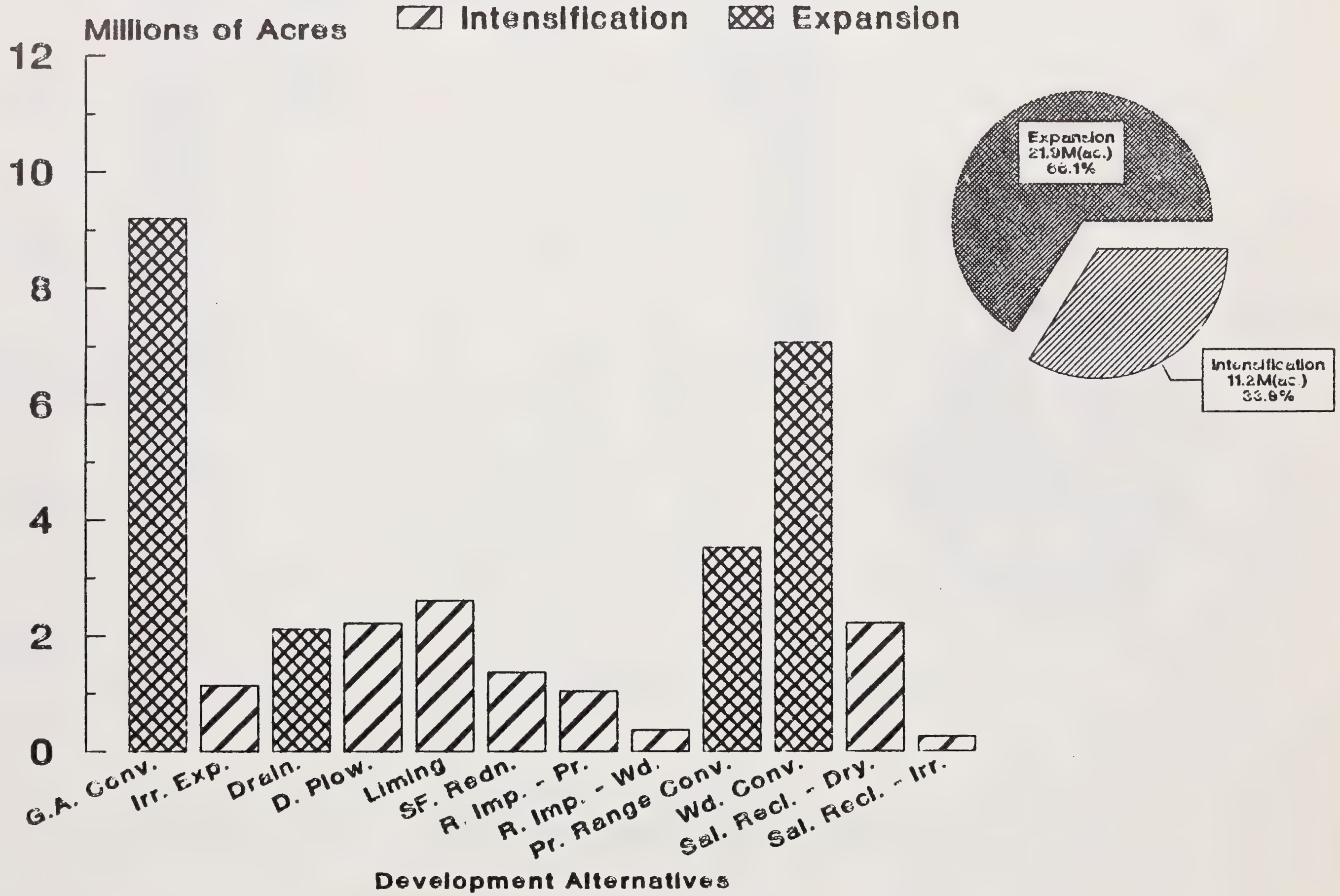


Figure 5.2 Provincial Summary Total Area Distribution



alternatives, specifically Irrigation-related options, illustrate the greatest per acre potential for increasing agricultural production. The expansion alternatives per acre estimates range from $50-$115, whereas the intensification alternatives range from $20-$270 per acre. Intensification alternatives which pertain to soil improvement options such as Deep Plowing, Liming, and Saline Soil Reclamation-Dryland produce production estimates averaging from $20 to $80 annually. Intensification opportunities which pertain to irrigation such as Irrigation Expansion and Saline Soil Reclamation-Irrigated indicate considerably larger production per acre estimates which average more than $200.

Regional analyses are used to illustrate the distribution of development opportunities across the province and to identify differences in the distribution of acreages available or the corresponding production potential with full implementation. The original Inventory data were generated on the basis of soil zones. Soil zone subtotals may be aggregated in different combinations to facilitate the examination of data from a regional perspective. The following soil zones were aggregated to define the three regions used in the Agricultural Land Base Study: Northern (Luvisols-Green Area and Luvisols-Peace River soil zones); Central (Luvisols-Central and Black soil zones); and Southern (Dark Brown and Brown soil zones). The Soil Zones Map illustrates the three broad regions prepared for this analysis (Figure 5.3).

In total, the acreages available for development and the corresponding production potentials are uniformly distributed among the Northern, Central and Southern regions (Figures 5.4, 5.5). The Northern region accounts for approximately 40 percent, 14 million acres and $1065 million annually,of the total provincial development potential. The remaining development potential is equally distributed among the Central (30 percent), 10 million acres and $740 million annually, and Southern (30 percent), 9 million acres and $690 million annually, regions. The average value of production per acre remains constant at $75 for all three regions. However, the number and types of

Figure 5.4 Generalized Study Regions
Total Value of Production
(Millions of Dollars)

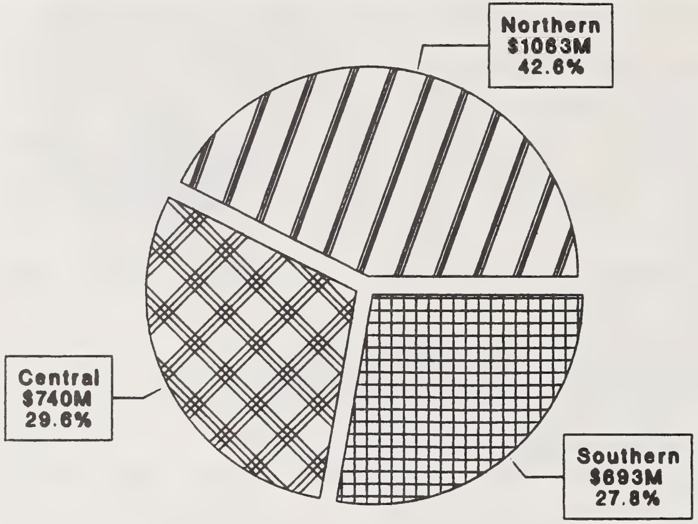
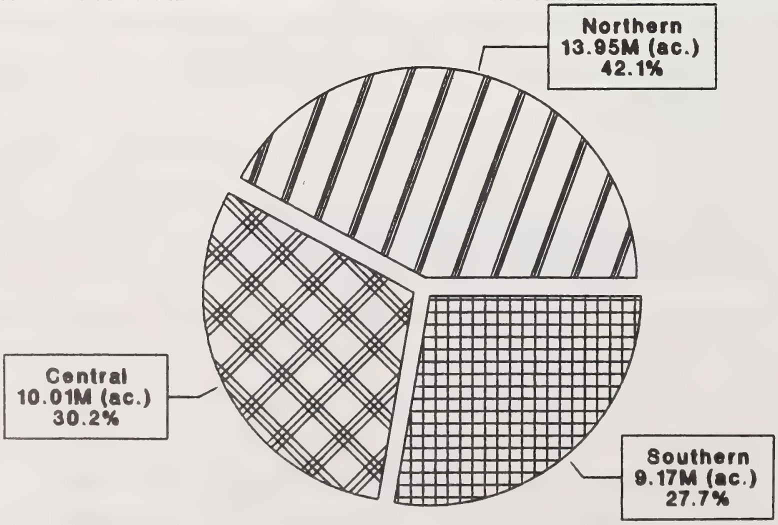
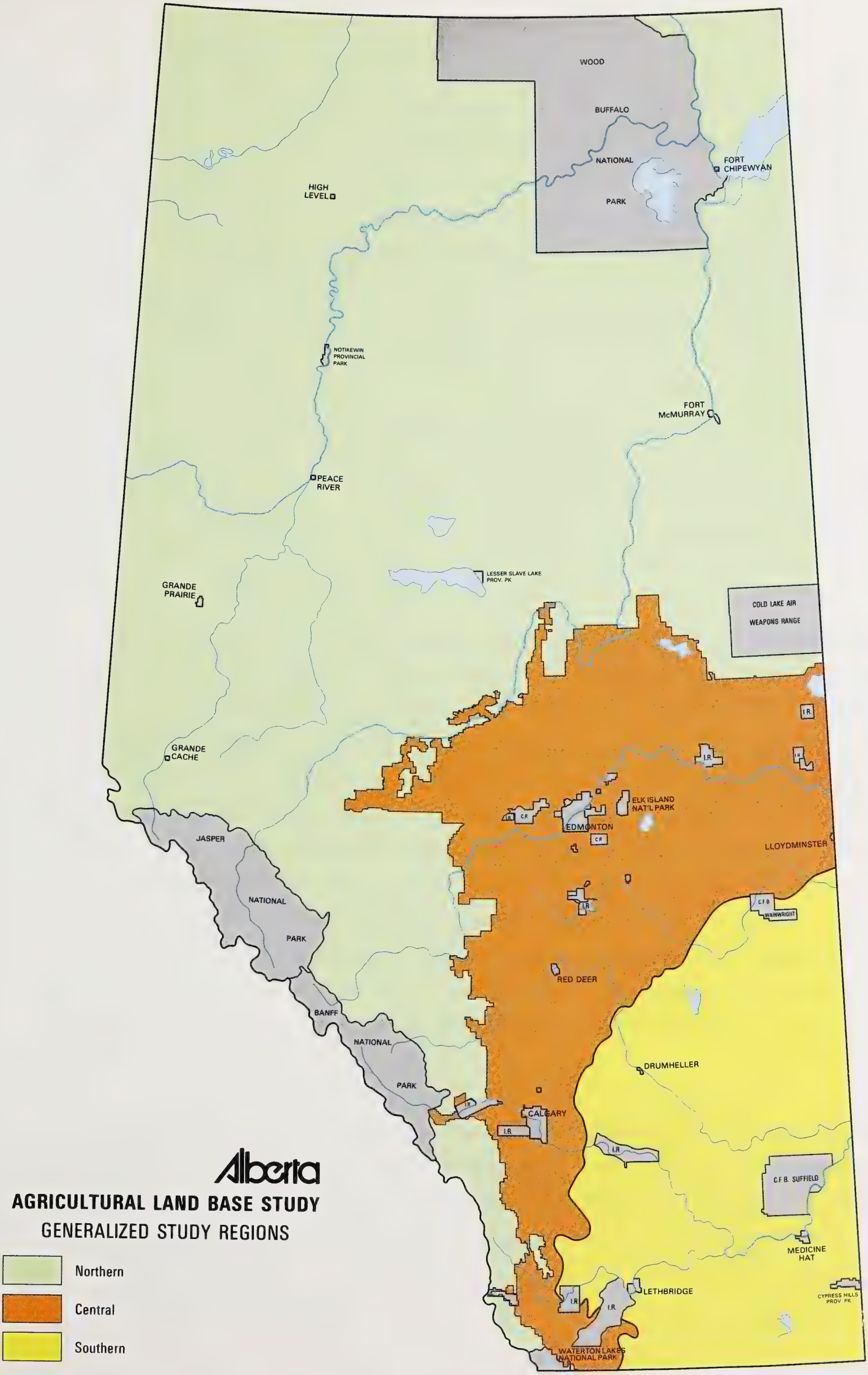


Figure 5.5 Generalized Study Regions
Total Area Distribution
(Millions of Acres)





Alberta

AGRICULTURAL LAND BASE STUDY

GENERALIZED STUDY REGIONS

🟩	Northern
🟧	Central
🟨	Southern

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA FORESTRY, LANDS AND WILDLIFE, 1986.

development alternatives contributing to the regional potential vary significantly. Only two development alternatives, Green Area Conversion and Woodland Conversion, contribute significantly to the Northern region's development potential. In the Central region several smaller alternatives contribute to the regions development potential: Woodland Conversion, Drainage, Deep Plowing and Range Conversion. The Southern region also has several significant contributing development opportunities: Irrigation Expansion, Range Conversion, Summerfallow Reduction and Saline Soil Reclamation. In summary, the regional agricultural development potential is greatest in Northern Alberta; however fewer significant alternatives are available to promote development within this region. In contrast, Central and Southern Alberta have a somewhat lower total development potential, but there are a greater number of significant opportunities contributing to this potential.

From a regional perspective, there is a definite stratification among the grouped expansion and intensification development opportunities (Figures 5.6 through 5.11). For both the total acreage and potential production estimates, there is an overwhelming emphasis towards expansion opportunities in the Northern region. The Central region presents a more even mixture of expansion and intensification opportunities, with a slight emphasis on expansion development alternatives (primarily for total value of production). Finally, there is a noteable shift in the weighting towards intensification opportunities in the Southern region. Although the total development potential is greatest in the Northern region, there is a greater number and variety of alternatives contributing to the development potential of the Central and Southern regions.

Variability in the distribution of development opportunities across the province can also be examined by soil zones. Further detailed summaries recording the degree to which individual crop types contribute to total production estimates by soil zones are provided in appendix 4.

Figure 5.6 Northern Region
Total Value of Production
(Millions of Dollars)

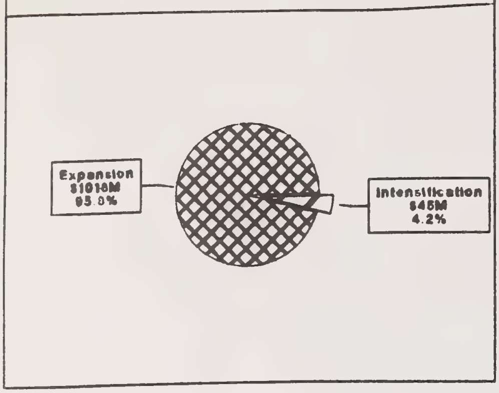


Figure 5.9 Northern Region
Total Area Distribution
(Millions of Acres)

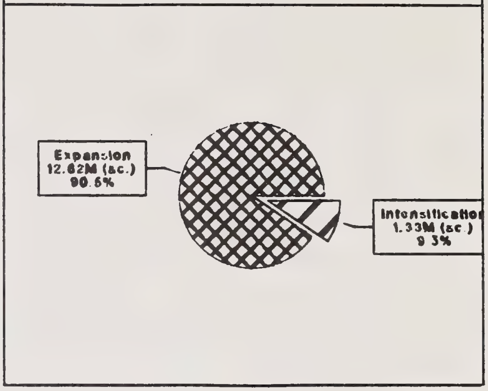


Figure 5.7 Central Region
Total Value of Production
(Millions of Dollars)

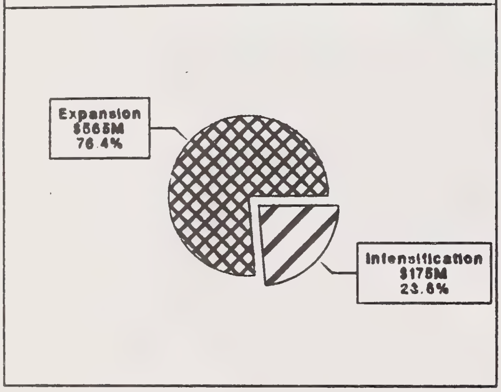


Figure 5.10 Central Region
Total Area Distribution
(Millions of Acres)

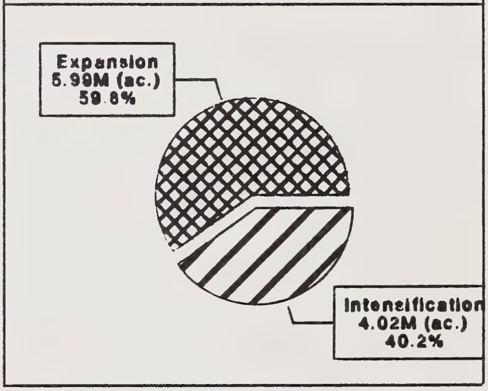


Figure 5.8 Southern Region
Total Value of Production
(Millions of Dollars)

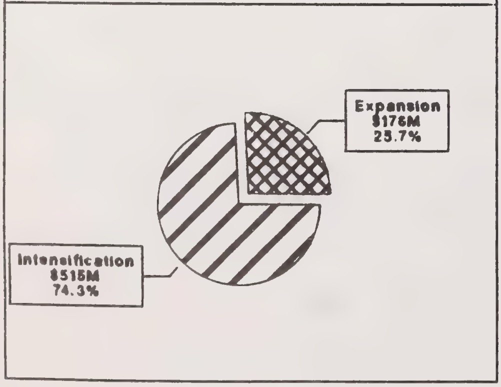
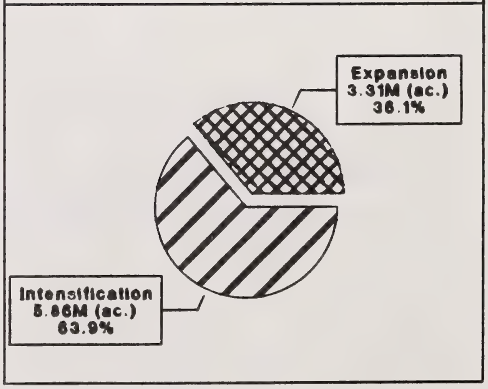


Figure 5.11 Southern Region
Total Area Distribution
(Millions of Acres)



Alberta has a total of 52 million acres of CLI class 1-4 lands physically capable of producing annual field crops. The 1981 census indicates that there are approximately 30 million acres of improved farmland in the province. Improved lands are defined to include cropland, summerfallow, improved pasture and other improved lands (farmyards, roads on farms, and lands recently broken but not yet seeded to crop). Improved croplands (croplands and summerfallow), primarily CLI Class 1-4 lands, totalled 27 million acres in 1981. The 22 million acres defined as expansion opportunities in this study represent most of the remaining lands available, which are currently undeveloped, for annual field crop production in Alberta. The shortfall of approximately 3 million acres resulted from deletions to the study's expansion acreage estimates made in recognition of special conservation concerns. Based on Public Lands experience, a minimum of 10-15 percent of all new lands identified for agricultural expansion are withheld because of fragmentation, access or landscape limitations. The additional 11 million acres identified as intensification opportunities brings the total area which may be improved for agriculture to 33 million acres.

The total area examined in the Agricultural Inventory is roughly equal in size to Alberta's currently improved land base. However, the resulting production increases from full implementation only represent a two-thirds increase in 1984 Annual Farm Cash Receipts. The proportionately lower increase in the value of agricultural production emphasizes a key difference between those lands identified for future agricultural development and those lands currently in production. More than 100 years of settlement in Alberta has resulted in extensive development of the province's higher capability agricultural lands. Consequently the productivity of many of the development alternatives examined in the Agricultural Land Base Study are restricted by lower natural soil fertility. It is estimated that 90 percent of the lands identified for agricultural expansion are rated as lower capability CLI class 4 lands. Intensification opportunities, with the exception of the Irrigation related alternatives, result in smaller incremental increases in production on lands currently devoted to agricultural production. As many of the lands discussed in this study are more susceptible to wind and water erosion, flooding, poor drainage, salinity or acidity it should be recognized that these lands are not as productive as the existing improved land base.

The Agricultural Land Base Study is designed as a long-range tool for planning future agricultural development in Alberta and is not an implementation study. The results of this report indicate that Alberta's land and water resources should not restrict the future growth of the agricultural industry. It is also significant to note that Alberta has a broad range of development alternatives available for agricultural development. All ten development alternatives examined represent significant opportunities for increasing agricultural production across the province.

Increased agricultural production is just one of the criteria by which the Agricultural Land Base Study has evaluated each alternative. Any significant initiative to more effectively manage Alberta's resources for agricultural production needs to consider a number of approaches and their impacts on other resource uses. The Agricultural Inventory represents one component of the Agricultural Land Base Study. Final conclusions can only be drawn in collective consideration of each of the remaining five background reports. The five technical background reports prepared for this study are:

1. Agricultural Land Base Study: Agricultural Inventory.
   A determination of the amount and location of land suitable for development and the corresponding potential increase in agricultural production with full implementation.

2. Agricultural Land Base Study: Economic and Financial Analysis: Direct Benefits and Costs.
   An analysis of the on-farm costs and returns associated with each of the options.

3. Agricultural Land Base Study: Analysis of Impacts on Other Resources.

   An identification of the impacts of agricultural development on other land and water resource users.

4. Agricultural Land Base Study: Economic Impact Analysis

   A summary from a societal perspective, of the direct and indirect benefits of each of the agricultural development options, their public investment requirements and the foregone benefits in other resource sectors.

5. Agricultural Land Base Study: Government Programs Promoting Agricultural Expansion and Intensification.

   A review of current government programs relevant to the objectives of the study.

APPENDIX I

Municipalities Aggregated Into Soil Zones*

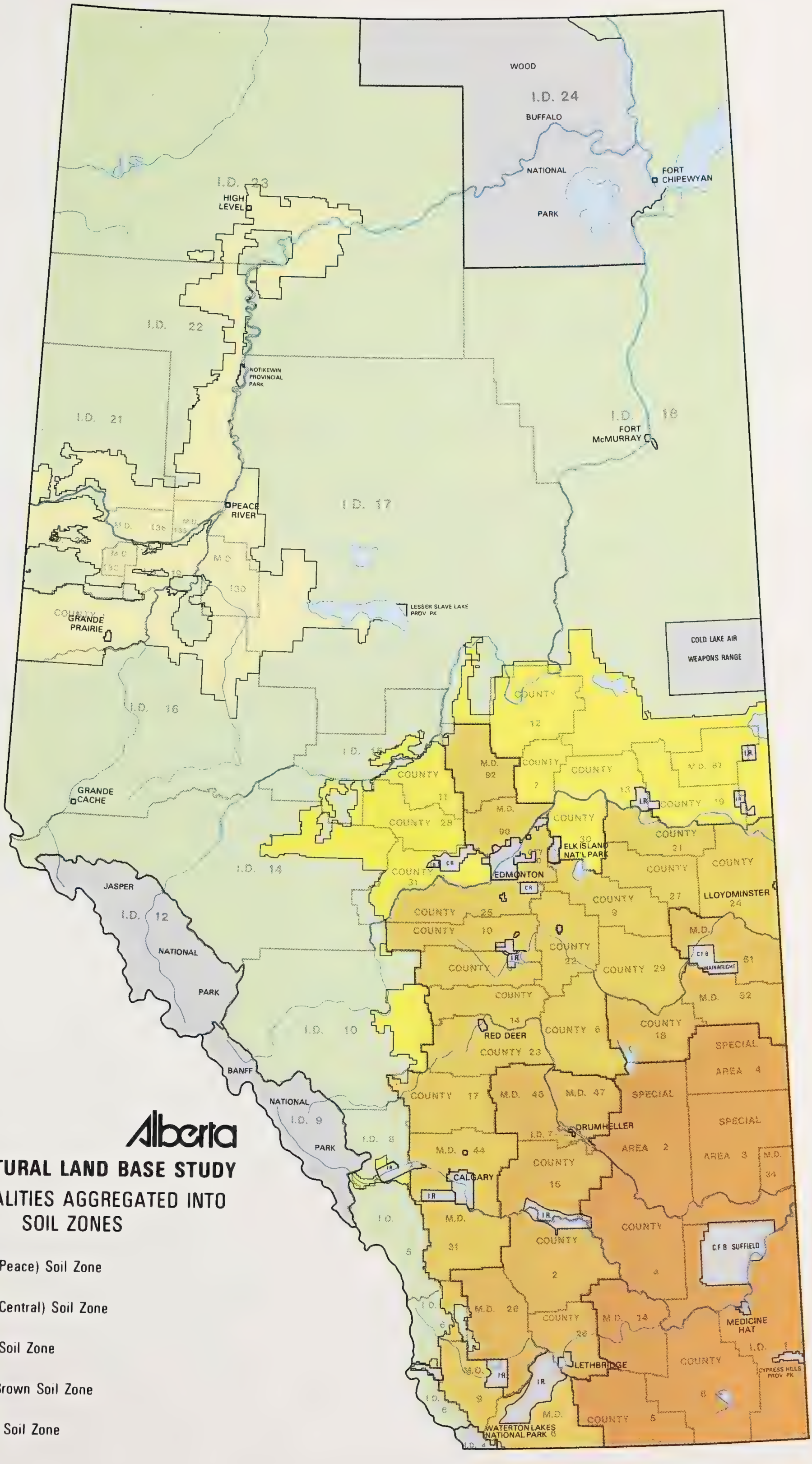
Brown	Dark Brown	Brown	Luvisols (white zone)	Luvisols (yellow zone)	
ID 6	MD 26	ID 1	C 31	ID	22
MD 6	C 26	C 8	C 28	ID	21
MD 9	C 2	C 5	C 11	MD	133
MD 31	C 16	MD 14	C 7	ID	20
MD 44	MD 48	C 4	C 13	C 1	
C 17	MD 47	SA 2	C 19	MD 135	
C 23	C 18	SA 3	MD 87	MD 136	
C 6	MD 52	SA 4	C 12	ID 19	
C 14	MD 61	MD 34	ID 8	MD 130	
C 3	ID 7		ID 10	ID 23	
C 10			ID 11	ID 17	
C 25			ID 14	ID 16	
C 22			ID 15		
C 29			ID 18		
C 20					
C 9					
C 27					
C					24
MD 90					
C 30					
C					21
MD 92					

Missing Municipalities	Undifferentiated Mountain Complex	Elk Island National Park	Brown Wooded and Acid Brown Soils
	ID 4	ID 13	ID 24
	ID 5		
	ID 9		
	ID 12		

ID = improvement district   C = county   MD = municipal district

* municipal units were aggregated into a specific soil group on the basis of the major soil group occurring in the municiple unit.

Derived from Land Needs For Agriculture (Alberta Land Use Forum, Technical Report #5, 1974)



Alberta

AGRICULTURAL LAND BASE STUDY

MUNICIPALITIES AGGREGATED INTO SOIL ZONES

- Gray (Peace) Soil Zone
- Gray (Central) Soil Zone
- Black Soil Zone
- Dark Brown Soil Zone
- Brown Soil Zone

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA ENERGY AND NATURAL RESOURCES, 1985.

APPENDIX II

CLI: SOIL CAPABILITY FOR AGRICULTURE

The CLI data base is used in the ALBS because it is the only data base with complete coverage of lands with developable agricultural capability and the system is reliable for this kind of broad overview. Many of the subjective decisions required by CLI were made using existing soil surveys that had classified and mapped soil based on inherent characteristics and soil surveys that were under preparation. Where soil survey information was unavailable air photo interpretation was utilized. Further information was acquired from climatological records and publications, and from crop data reports of the Department of Soil Science, University of Alberta and Agriculture Canada Research Stations.

CLI was a classification of physical capability and made a number of assumptions, many of which could directly affect the suitability and productivity of the land. These assumptions were:

1. Shrubs and trees are not considered limitations unless it is impossible to remove them.
2. The soils will be cropped under mechanized systems with good management practices.
3. The system does not classify limitations that can be overcome by the farmers.
4. Distance to market, kinds of roads, location, size of farm, characteristics of land ownership, cultural patterns and skill or resources of the farmer were not considered.

The CLI Soil Capability for Agriculture classification groups mineral soils into seven classes according to their potentials and limitations for agriculture:

Soil Capability Class 1

Class 1 soils occur in areas having no climatic limitations or in areas where climatic limitations (aridity) have been altered by irrigation. The areas with no climatic limitations occur within the Black and northern portions of the Dark Brown soil groups. The areas in which climatic limitations have been altered by irrigation occur within the Brown and Dark Brown soil groups in southern Alberta. There are approximately two million acres of Class 1 soils in Alberta for both irrigated and dryland conditions which represents less than two percent of the total area covered by the Canada Land Inventory.

These soils have deep, humus-rich surface horizons, a high available moisture holding capacity, a high natural fertility status and respond well to fertilizer application. They are easily managed, have good tilth, and are highly productive for a wide range of crops common to the region. The landscape features are ideal: slopes are gentle; drainage is well to moderately well; stones are absent or present in amounts which present no limitation. Soils in this class have no significant limitations to use for crop production.

Soil Capability Class 2

Class 2 soils are the best soils in areas where there are climatic limitations due to either a lack of precipitation or a shortened growing season. Class 2 soils also occur in areas having no climatic limitations but have a moderate degree of limitation due to adverse soil or landscape characteristics. These soils are found throughout the Black, Dark Brown, Brown, Dark Gray, and Dark Gray Wooded soil groups. There are about 10 million acres of Class 2 soils in Alberta for both irrigated and dryland conditions.

Soil characteristics include moderately deep humus-rich surface horizons, a moderately high available moisture holding capacity, a moderately high natural fertility status, and the ability to respond well to fertilization. Landscape limitations such as adverse topography can occur. The above mentioned limitations either singly or in combination, impart a moderate degree of limitation to agricultural use. However, with good management and the application of conservation practices to prevent soil deterioration and/or to improve air and water relationships, these limitations are easily overcome. In fact, in years of favorable precipitation and temperature, Class 2 soils are comparable with Class 1 soils in productivity. Soils in this class have moderate limitations that restrict the range of crop production or require moderate conservation practices.

Soil Capability Class 3

Class 3 soils occur in Climatic Areas 1 and 2 with moderate to moderately severe soil and/or landscape limitations and in Climatic Area 3 with no soil or landscape limitations. Thus, Class 3 soils are found throughout all the soil groups in Alberta. There are approximately 16 million acres of Class 3 soils in Alberta for both irrigated and dryland conditions.

Since such a large variety of soils fall within the Class 3 category it follows that a wide range of climatic, soil, and landscape characteristics can impose limitations, either singly or in combination. These limitations place moderately severe restrictions on agricultural use and tend to reduce the range of crops that can be grown or make special conservation practices a requirement. The conservation practices are usually more difficult to apply and maintain than for Class 2 soils. The limitations may adversely affect the timing of cultivation, seeding, or harvest; the ease of tillage; choice of crops; or any combination of these factors to such an extent that Class 3 soils are only medium to moderately high in productivity. Soils in this class have moderately severe limitations that restrict the range of crops produced or require special conservation practices.

Soil Capability Class 4

Class 4 soils occur throughout the province in Climatic Areas 1, 2, and 3 and in all soil groups. There are about 24.5 million acres of Class 4 soils within the area covered by the Canada Land Inventory. Many combinations of adverse climatic, soil, and/or landscape characteristics result in these soils having such severe limitations that they are suited only for a very narrow range of crops and the risk of crop failure is high. Even with high inputs of management, these soils are low to medium in productivity, however, specially adapted crops may be successfully grown. Soils in this class have severe limitations that restrict the range of crops and/or require special conservation practices.

Soil Capability Class 5

Class 5 soils occur throughout the province in areas that have very severe limitations as a result of adverse climatic, soil, and/or landscape characteristics. There are more than 28 million acres of Class 5 soils in Alberta within the area covered by the Canada Land Inventory. The severity of the limitations of these soils renders them unsuitable for annual cultivation. However, depending on the nature of the limitation, Class 5 soils may be improved for the production of perennial forages and pastures. Improvement practices may include brush clearance, fertilization, seeding and drainage. Soils in this class have very severe limitations that restrict their capability to produce perennial forage crops, but improvement practices are feasible.

Soil Capability Class 6

Class 6 soils occur in all areas of the province. There are more than nine million acres of these soils within the area covered by the Canada Land Inventory in Alberta. Class 6 soils have such severe limitations that improvements are not feasible, but they do have some natural grazing potential. Included in Class 6 are areas with extreme topography (river banks, foothils, mountains), extremely droughty soils (sand dunes), very poorly drained soils (peaty Gleysols), and areas with severe climatic restrictions. Soils in this class are capable of producing perennial crops, but improvement practices are not feasible.

Soil Capability Class 7

Class 7 includes all areas not included in Classes 1 to 6. It includes areas with no agricultural potential such as rock outcrops, small bodies of water, urban and industrial lands, areas too steep for grazing animals and areas with a natural vegetative cover that offer no grazing potential for domestic animals. In Alberta, there are more than 11.5 million acres of Class 7 land, more than five million acres of parks and urban areas, and about 1.8 million acres of water surfaces within the area covered by the Canada Land Inventory. Soils in this class have no capability for crop production or permanent pasture.

Organic Soils

Includes all peat land (muskeg) and meadow areas that are classified as Organic soils (see System of Soil Classification for Canada for definition of Organic Soils). Criteria have not been established for evaluating organic soils under the Canada Land Inventory System, hence all organics are grouped together and designated by the Letter O on the Soil Capability for Agriculture maps. There are more than 12.5 million acres of Organic soil areas in Alberta within the area covered by the Canada Land Inventory. Organic soils are not placed in capability classes.

In summary, each class includes many types of soil, and many of the soils in a class may require different management and treatment. The CLI classification was intended to be a classification of the variety of crops that could be successfully grown rather than crop yield. For example, Class 1 land in Alberta can be used for market gardening, wheat, oats, barley, rye oilseeds, or tame or native forages, whereas Class 5 land can only sustain tame or native forage. In other words, the poorer the class, the fewer the cropping options.

Certain constraints had to be built into the classification system so that CLI Soil Capability for Agriculture could meet its objective of being a broad comprehensive inventory. Homogeneous polygons rarely appear in the CLI Soil Capability for Agriculture classification because it was based on reconnaissance level soil surveys. Small inclusions (less than 10 per cent) of different classes were impossible to symbolize on the map due to the small scale of mapping. In addition, capability maps were reduced in scale so that grouping of soil units was required thus increasing the complexity of individual units. In many cases different soils had to be grouped together because they had the same level of limitations even though they had different kinds of limitations.

CLI Soil Capability for Agriculture data should therefore, not be used without a full understanding of its objectives and design. CLI was designed to paint a picture of national and regional capabilities; it was not intended for use at detailed or site specific scales because of the limitations associated with the broad nature of the fieldwork, cartographic restrictions and complexity of mapped units. Although some crop productivity data were used in the classification, CLI Soil Capability for Agriculture was not intended to be a classification of crop productivity. However, CLI Soil Capability for Agriculture is a reasonably reliable and adequate data base to construct a broad overview of agricultural capability in Alberta. It is based on soil and climate data relevant to agriculture and is the only data base that has a broad enough coverage to be used in this agricultural capability analysis. Total provincial acreage estimates for each of the described classes are recorded in the following table.

CANADA LAND INVENTORY SOIL CAPABILITY FOR DRYLAND AGRICULTURE

(Acreage by Soil Zones)

		CLI Classes					
Soil Zone	Land Designation	1-4	5	6+7+ Organics	8	N/C	Total Area
Black	White Area	14,386,853	2,442,583	549,551	306,140	--	17,685,127
	Green Area[1]	2,471	69,434	1,273,802	3,460	--	1,349,167
	Total	14,389,324	2,512,017	1,823,353	309,600	--	19,034,294
Dark Brown	White Area	6,783,882	1,143,826	818,643	59,733	1,236	8,807,320
	Green Area	988	26,438	5,189	--	--	32,615
	Total	6,784,870	1,170,264	823,832	59,733	1,236	8,839,935
Brown	White Area/ Total	7,165,654	4,617,064	1,755,893	848,744	--	14,387,355
Luvisols (Central)	White Area	5,506,377	2,072,429	1,848,803	305,452	--	9,733,061
	Green Area[1]	1,157,911	4,849,091	7,607,963	1,325,939	13,880,100	28,821,004
	Total	6,664,288	6,921,520	9,456,766	1,631,391	13,880,100	38,554,065
Luvisols (Peace)	White Area	8,093,511	762,798	1,901,196	420,557	247	11,178,309
	Green Area	9,556,345	13,754,821	12,140,270	330,867	8,905,237	44,687,540
	Total	17,649,856	14,517,619	14,041,466	751,424	8,905,484	55,865,849
Remaining Province	White Area[2]	24,216	36,821	35,830	247	--	97,114
	Green Area	494	29,899	303,439	3,788,537	785,778	4,908,147
	Total	24,710	66,720	339,269	3,788,784	785,778	5,005,261
PROVINCIAL TOTAL		52,678,702	29,805,204	28,240,579	7,389,676	23,572,598	141,686,759

CLI Class 8 - Includes waterbodies, provincial parks, national parks and built-up areas. A review of the published statistics showed many lakes and rivers omitted under CLI class 8. For the White area only, the acreage of major lakes and rivers was taken off a base map and added to CLI class 8 for each soil zone.

N/C category - Includes land outside of the CLI area.

1. - Includes land designations 8 (unclassified) and b (no coverage).

APPENDIX III

BREAKDOWN OF EXCLUSIONS THAT OCCURRED ON CLI CLASS 1-4 AND 5 LANDS FOR EACH SOIL ZONE
(Acres)

Soil Zone		Green Area	Towns	Urban Centres	Roads	Indian Reserves	Military Ranges	Zoned Co. Res. Indust.[1]	Other[2]	Total
Black	CLI 1-4	2,471	60,800	74,081	476,593	476,376	4,201	91,818	5,760	1,192,100
	CLI 5	69,434	7,037	6,425	78,427	91,631	--	17,862	640	271,456
	Total	71,905	67,837	80,506	555,020	568,007	4,201	109,680	6,400	1,463,556
Dark Brown	CLI 1-4	998	4,960	24,957	250,330	111,232	12,160	--	2,240	406,877
	CLI 5	26,438	1,280	1,235	38,512	36,026	12,160	--	--	115,651
	Total	27,436	6,240	26,192	288,842	147,258	24,320	--	2,240	522,528
Brown	CLI 1-4	--	16,159	2,965	216,919	--	494	--	17,840	254,377
	CLI 5	--	160	3,707	143,166	--	247	--	6,000	153,280
	Total	--	16,319	6,672	360,085	--	741	--	23,840	407,657
Luvisols (Central)	CLI 1-4	1,157,911[3]	21,240	--	276,283	131,470	6,178	177,078	160	1,770,320
	CLI 5	4,849,091[3]	1,602	--	104,987	80,993	1,236	32,320	--	5,070,229
	Total	6,007,002	22,842	--	381,270	212,463	7,414	209,398	160	6,840,549
Luvisols (Peace)	CLI 1-4	9,556,345	5,280	5,683	335,085	106,320	--	--	80	10,008,793
	CLI 5	13,754,821	--	--	32,131	2,760	--	--	1,200	13,790,912
	Total	23,311,166	5,280	5,683	367,216	109,080	--	--	1,280	23,799,705

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1. Only large blocks of zoned country residential developments were included in the exclusions. Small single and multi country residential totals are not included. From 1976 to 1980 Alberta had a total of 95,770 acres of small single and multi country residential holdings. (An Inventory of Changes in Alberta's Agricultural Land Base Between 1976 and 1980. Resource Economics, 1982).

2. Includes airports and provincial parks not deleted under CLI Class 8.

3. Includes land designation 8 (unclassified by land designation).

Sources:

- Alberta Energy and Natural Resources, 1983. Soil Capability for Agriculture, a Summary and Application of Canada Land Inventory Data in Alberta. Resource Evaluation and Planning, Resource Planning Branch, Regional Planning Section, Alberta Energy and Natural Resources. Technical Report No. I/45.

- Alberta Transportation, 1984. Kilometres as of March 31, 1984. Primary Highways by Municipality.

- Alberta Transportation Regional Transportation Division, 1984. Kilometres as of March 31, 1984. Summary by County for APP and PRK.

- Alberta Native Affairs. The Agricultural Potential of Native Communities Phase I. Draft Document.

- Alberta Municipal Affairs. Zoned County Residential and Industrial Lands outlined on 1:250,000 Alberta Base Maps. Acreage by CLI classes estimated by the Land Use Branch using 1:250,000 Canada Land Inventory Soil Capability For Agriculture Maps.

- Acreage of towns by CLI classes estimated by the Land Use Branch using 1:1,000,000 Alberta Base Maps and 1:1,000 000 Canada Land Inventory Soil Capability For Agriculture Maps.

AGRICULTURAL LAND USE BY SOIL ZONES (1981)
(ACRES)

SOIL ZONE	TOTAL FARM AREA	IMPROVED LAND					UNIMPROVED LAND		
		CROPS	PASTURE	SUMMERFALLOW	OTHER	TOTAL	WOODLAND	OTHER	TOTAL
Black	15,835,390	8,476,680	1,593,094	1,229,925	303,187	11,602,886	355,741	3,876,763	4,232,504
Dark Brown	7,965,708	3,850,870	521,780	1,477,162	91,349	5,941,161	28,223	1,996,324	2,024,547
Brown	11,562,417	3,035,181	668,458	1,692,337	80,354	5,476,330	27,362	6,058,725	6,086,087
Luvisols (Central)	5,598,176	2,359,689	794,041	282,819	123,681	3,562,230	394,074	1,641,872	2,035,946
Luvisols (Peace)	6,107,153	3,068,708	318,943	748,218	131,382	4,267,251	406,632	1,433,270	1,839,902
Provincial Total	47,068,844	20,791,128	3,896,316	5,430,461	731,953	30,849,858	1,212,032	15,006,954	16,218,986

Source: Alberta Agriculture 1982. 1981 Census of Agriculture for Alberta I.D., M.D., and County Data by Region.

APPENDIX IV

VALUE OF AGRICULTURAL PRODUCTION BY SOIL ZONES

SOIL ZONES	DEVELOPMENT ALTERNATIVE	VALUE OF PROD. (Millions of Dollars)	AREA (Millions of Acres)	VALUE OF PRODUCTION (Dollars per Acre)
BROWN				
1	Irrigation Expansion	$254	0.90	282.22
2	Prairie Range Conversion	$ 79	2.00	39.50
3	Salinity - Irrigated	$ 39	.19	205.26
4	Summerfallow Reduction	$ 37	.45	82.22
5	Drainage	$ 12	.19	70.59
6	Salinity - Dryland	$ 11	.62	17.74
7	Deep Plowing	$ 8	.52	15.38
8	Range Improvement	$ 7	.76	9.21
9	Liming	$ 1	.09	11.11
DARK BROWN				
1	Prairie Range Conversion	$ 61	.89	68.54
2	Irrigation Expansion	$ 53	.23	230.44
3	Summerfallow Reduction	$ 55	.46	119.57
4	Drainage	$ 26	.25	104.00
5	Salinity - Dryland	$ 18	.69	26.09
6	Salinity - Irrigated	$ 14	.06	233.33
7	Deep Plowing	$ 10	.53	18.87
8	Range Improvement	$ 4	.13	30.77
9	Liming	$ 4	.23	17.39
BLACK				
1	Woodland Conversion	$179	2.13	84.04
2	Drainage	$113	.90	125.56
3	Deep Plowing	$ 64	1.17	54.70
4	Prairie Range Conversion	$ 52	.64	81.25
5	Salinity - Dryland	$ 25	.78	32.05
6	Summerfallow Reduction	$ 23	.26	88.46
7	Liming	$ 21	.94	22.34
8	Range Improvement	$ 8	.16	50.00
GRAY (CENTRAL)				
1	Woodland Conversion	$160	1.80	88.88
2	Drainage	$ 61	.52	117.31
3	Liming	$ 22	.31	19.35
4	Range Improvement	$ 6	.26	84.62
5	Summerfallow Reduction	$ 3	.03	100.00
6	Salinity - Dryland	$ 3	.11	27.27
GRAY (PEACE)				
1	Woodland Conversion	$228	3.14	72.61
2	Drainage	$ 28	.28	100.00
3	Summerfallow Reduction	$ 19	.18	105.56
4	Liming	$ 17	1.03	16.50
5	Range Improvement	$ 8	.10	80.00
6	Salinity - Dryland	$ 1	.02	50.00
GRAY (GREEN AREA)				
1	Green Area Conversion	$762	9.20	82.83

INCREASES IN AGRICULTURAL PRODUCTION BY DEVELOPMENT ALTERNATIVES:

__Wheat__: (Millions of Bushels)

SOIL ZONES	GREEN AREA EXPANSION	IRRIGATION* EXPANSION	SOLONETZIC SOILS	ACID SOILS	SUMMERFALLOW REDUCTION	DRAINAGE POTENTIAL	RANGE IMPROVMENT	RANGE CONVERSION	WOODLAND CONVERSION	SALINE RECLAMATION	SOIL ZONE TOTAL
BROWN		31.70	1.41	0.18	5.97	1.85		16.00		6.08	63.19
DARK BROWN		7.18	1.68	0.51	6.37	3.20		8.01		3.45	30.40
BLACK			3.73	1.34	1.92	6.67		3.32	11.04	1.44	29.46
GRAY (CENTRAL)				0.24	0.08	1.36			3.54	0.07	5.29
GRAY (PEACE)				1.14	1.02	1.51			13.28	0.03	16.98
GRAY (GREEN AREA)	39.01										39.01
"TOTAL INCREASE IN AGRICULTURAL PRODUCITON	39.01	38.88	6.82	3.41	15.36	14.60		27.33	27.86	11.07	184.34

INCREASES IN AGRICULTURAL PRODUCTION BY DEVELOPMENT ALTERNATIVES:

Oats: (Millions of Bushels)

SOIL ZONES	GREEN AREA EXPANSION	IRRIGATION* EXPANSION	SOLONETZIC SOILS	ACID SOILS	SUMMERFALLOW REDUCTION	DRAINAGE POTENTIAL	RANGE IMPROVMENT	RANGE CONVERSION	WOODLAND CONVERSION	SALINE RECLAMATION	SOIL ZONE TOTAL
BROWN		0.98	0.25	0.01	0.47	0.14		1.18		0.28	3.31
DARK BROWN		0.02	0.33	0.04	1.12	0.45		1.13		0.36	3.45
BLACK			1.98	0.42	1.23	3.97		1.99	6.63	0.86	17.08
GRAY (CENTRAL)				0.27	0.19	3.21			7.85	0.19	11.73
GRAY (PEACE)				0.23	0.44	0.63			5.51	0.01	6.87
GRAY (GREEN AREA)	16.24										16.24
"TOTAL INCREASE IN AGRICULTURAL PRODUCITON	16.24	1.00	2.56	0.97	3.45	8.40		4.30	19.99	1.70	58.68

INCREASES IN AGRICULTURAL PRODUCTION BY DEVELOPMENT ALTERNATIVES:

Barley: (Millions of Bushels)

SOIL ZONES	GREEN AREA EXPANSION	IRRIGATION* EXPANSION	SOLONETZIC SOILS	ACID SOILS	SUMMERFALLOW REDUCTION	DRAINAGE POTENTIAL	RANGE IMPROVMENT	RANGE CONVERSION	WOODLAND CONVERSION	SALINE RECLAMATION	SOIL ZONE TOTAL
BROWN		12.33	0.30	0.06	1.48	0.44		3.73		2.07	20.41
DARK BROWN		1.74	0.47	0.46	4.72	2.17		5.75		2.07	17.38
BLACK			20.68	4.05	0.95	15.80		7.95	26.45	3.43	79.31
GRAY (CENTRAL)				1.37	0.37	6.66			16.23	0.35	24.98
GRAY (PEACE)				2.93	2.10	3.25			28.57	0.32	37.17
GRAY (GREEN AREA)	83.63										83.63
"TOTAL INCREASE IN AGRICULTURAL PRODUCITON	83.63	14.07	21.45	8.87	9.62	28.32		17.43	71.25	8.24	262.88

INCREASES IN AGRICULTURAL PRODUCTION BY DEVELOPMENT ALTERNATIVES:

Canola: (Millions of Bushels)

SOIL ZONES	GREEN AREA EXPANSION	IRRIGATION* EXPANSION	SOLONETZIC SOILS	ACID SOILS	SUMMERFALLOW REDUCTION	DRAINAGE POTENTIAL	RANGE IMPROVMENT	RANGE CONVERSION	WOODLAND CONVERSION	SALINE RECLAMATION	SOIL ZONE TOTAL
BROWN		0.27		0.003	0.01	0.03		0.25		0.08	0.65
DARK BROWN		-0.11		0.05	0.56	0.24		0.61		0.40	1.75
BLACK			0.68	0.30	0.44	1.42		0.71	2.37	0.31	6.23
GRAY (CENTRAL)				0.05	0.02	0.29			0.52	0.01	0.89
GRAY (PEACE)				0.40	0.38	0.56			4.90	0.05	6.29
GRAY (GREEN AREA)	14.30										14.30
"TOTAL INCREASE IN AGRICULTURAL PRODUCITON	14.30	0.16	0.68	0.80	1.41	2.54		1.57	7.79	0.55	29.80

INCREASES IN AGRICULTURAL PRODUCTION BY DEVELOPMENT ALTERNATIVES:

Hay: (Millions of Bushels)

SOIL ZONES	GREEN AREA EXPANSION	IRRIGATION* EXPANSION	SOLONETZIC SOILS	ACID SOILS	SUMMERFALLOW REDUCTION	DRAINAGE POTENTIAL	RANGE IMPROVMENT	RANGE CONVERSION	WOODLAND CONVERSION	SALINE RECLAMATION	SOIL ZONE TOTAL
BROWN		690.66			23.00	7.02		84.00		160.00	964.68
DARK BROWN		154.22			42.00	17.56		62.30		60.00	336.08
BLACK					66.10	215.91		153.60	500.00	50.00	985.61
GRAY (CENTRAL)					19.00	345.26			1190.00	20.00	1574.26
GRAY (PEACE)					48.00	71.94			800.00	1.00	920.94
GRAY (GREEN AREA)	2360.00										2360.00
"TOTAL INCREASE IN AGRICULTURAL PRODUCITON	2360.00	844.88			198.10	657.69		299.90	2490.00	291.00	7141.57

GLOSSARY

Acid soil   Any soil that has a pH less than 6.1.

Alkaline soil   Any soil that has a pH greater than 7.5.

Brown   A great group of soils in the Chernozemic order. The soils occur in the cool, subarid to semiarid grassland regions, and consist of a brown (dry) surface (Ah or Ap) horizon and ordinarily a lighter-coloured brownish B (Bm, Btj, or Bt) horizon, which may be absent, over a highly basesaturated, usually calcareous, C horizon.

Capability class   A rating that indicates the capability of land for some use such as agriculture, forestry, recreation, or wildlife. In the Canadian system, it is a grouping of lands that have the same relative degree of limitation or hazard. The degree of limitation or hazard is nil in Class 1 and becomes progressively greater to Class 7.

Chernozemic   An order of soils that have developed under xerophytic or mesophytic grasses and forbs, or under grassland-forest transition vegetation, in cool to cold, subarid to subhumid climates. The soils have a dark-coloured surface (Ah, Ahe, or Ap) horizon and a B or C horizon, or both, of high base saturation. The order consists of the Brown, Dark Brown, Black, and Dark Gray Great groups.

Soil Conservation   (i) Protection of the soil against physical loss by erosion or against chemical deterioration; that is, excessive loss of fertility by either natural or artificial means. (ii) A combination of all methods of management and land use that safeguard the soil against depletion or deterioration by natural or man-induced factors. (iii) The division of soil science dealing with soil conservation (i) and (ii).

Cultivation   Tillage to prepare land for seeding or transplanting, and later to control weeds and loosen the soil. See summerfallow.

Dark Brown A great group of soils in the Chernozemic order. The soils occur in the cool to cold, semiarid grassland regions and have a dark brown survace (Ah or Ap) horizon on a lighter coloured brownish B (Bm, Btj, or Bt) horizon, which may be absent, over a high base saturated, usually calcareous C horison.

Dark Gray A great group of soils in the Chernozemic order. The soils occur in the cool to cold, subhumid grassland-forest transitional regions, and have a dark gray partially eluviated surface (Ahe or Ap) horizon and a brownish B (Bm, Btj, or Bt) horizon, which may be absent, over a highly base saturated, usually calcareous C horizon.

Degradation (Anthropogenic) Changes in a soil, resulting from man's activities, which result in reduced land use options.

Degradation (Pedogenic) The changing of a soil to a more highly leached and weathered state, usually accompanied by morphological changes such as the development of an eluviated light-colored A (Ae) horizon.

Dryland farming The practice of growing crops without irrigation.

Fallow land Cultivated land that is not being used for a crop.

Soil Fertility The status of a soil in relation to the amount and availability to plants of elements necessary for plant growth.

Fertilizer Any organic or inorganic material of natural or synthetic origin that is added to a soil to supply certain elements essential to the growth of plants.

Fertilizer requirement The quality of certain plant nutrient elements needed, in addition to the amount supplied by the soil, to increase plant growth to a designated optimum.

Fine texture   Consisting of or containing large quantities of the fine fractions, particularly of silt and clay. It includes all the textural classes of clay loams and clays: clay loam, sandy clay loam, silty clay loam, sandy clay, silty clay, and clay. Sometimes it is subdivided into clayey texture and moderately fine texture.

Gray Luvisol   A great group of soils in the luvisolic order occurring in moderately cool climates, where mean annual temperature is the usually lower than 5.5 ˜C (42˜F). The soils have developed under deciduous and coniferous forest cover, and have an eluviated light-coloured surface (Ae) horizon, a brownish elluvial B (Bt) horizon, and usually a calcareous C horizon. The solum is base saturated (NaCl extraction). The Ahe horizon, if present, is less than 5 cm (2 inches) thick. This group includes soils formerly called Gray Wooded, Solonetz, Gray Brown Luvisol, Humic Podzol, Melanic Brunisol, Regosol, Gleysol, and Fibrisol.

Impeded drainage   A condition that hinders the movement of water by gravity through soils.

Soil Improvement   The processes for, or the results of, making the soil more productive for growing plants, by drainage, irrigation, addition of fertilizers and soil amendments, and so on.

Irrigation   The artificial application of water to the soil for the benefit of growing crops.

Land   The solid part of the earth's surface or any part thereof. A tract of land is defined geographically as a specific area of the earth's surface. Its characteristics embrace all reasonably stable, or predictably cyclic, attributes of the biosphere vertically above and below this area, including those of the atmosphere, the soil, and the underlying geology, the hydrology, the plant and animal populations, and the results of past and present human activity, to the extent that these attributes exert a significant influence on the present and future uses of land by man.

Leaching The removal from the soil of materials in solution.

Lime, agricultural A soil amendment consisting principally of calcium carbonate, and including magnesium carbonate and perhaps other materials. It is used to supply calcium and magnesium as essential elements for growth of plants and to neutralize soil acidity.

Lime requirement The amount of agricultural limestone, or the equivalent of another liming material, required per hectare to a soil depth of 15 cm (or for 2 240 t of soil) to raise the pH of the soil to specific value under field conditions.

Luvisolic An order of soils that have eluvial (Ae) horizons, and illuvial (Bt) horizons in which silicate clay is the main accumulation product. The soils developed under forest of forest-grassland transition in a moderate to cool climate.

Marl A soft, unconsolidated earthy deposit consisting of calcium carbonate or magnesium carbonate, or both, and often shells, usually mixed with varying amounts of clay or other impurities.

Medium texture Intermediate between fine-textured and coarse-textured soils. It includes the following textural classes: very fine sandy loam, loam, silt loam, and silt.

Neutral soil A soil in which the surface layer, to plow depth, is neither acid nor alklaine in reaction.

Organic matter The organic fraction of the soil; includes plant and animal residues at various stages of decomposition, cells and tissues of soil organisms, and substances synthesized by the soil population. It is usually determined on soils that have been sieved through a 2.0 mm sieve.

Parent material The unconsolidated and more or less chemically weathered mineral or organic matter from which the solum of a soil has developed by pedogenic processes.

pH, soil The negative logarithm of the hydrogen-ion activity of a soil. The degree of acidity or alkalinity of a soil as determined by means of a glass, quinhydrone, or other suitable electrode or indicator at a specified moisture content or soil-water ratio, and expressed in terms of the pH scale.

Productivity, soil The capacity of a soil, in its normal environment, to produce a specified plant or sequence of plants under a specified system of management. The "specified" limitations are needed because no soil can produce all crops with equal success and a single system of management cannot produce the same effect on all soils. Productivity means the capacity of soil to produce crops and is expressed in terms of yields.

Soil Reaction The degree of acidity or alkalinity of a soil, usually expressed as a pH value.

Reclamation Modification of a soil to overcome problems created or disturbance by man (e.g. mine reclamation).

Saline soil A nonalkali soil that contains enough soluble salts to interfere with the growth of most crop plants. The conductivity of the saturation extract is greater than 4 mmhos/cm, the exchangeable-sodium percentage is less than 15, and the pH is usually less than 8.5.

Saline-alkali soil (i) A soil containing enough exchangeable sodium to interfere with the growth of most crop plants, and containing appreciable quantities of soluble salts. The exchangeable-sodium percentage is greater than 15, the productivity of the saturation extract is greater than 4 mmhos/cm at 25°C, and the pH is usually 8.5 or less in the saturated soil. (ii) A saline alkali soil has a combination of harmful quantities of salts and either a high alkalinity or high content of exchangeable sodium, or both, so distributed in the profile that the growth of most crop plants is reduced. It is also called saline-sodic soil.

Soil Salinity The amount of soluble salts in a soil, expressed in terms of percentage, parts per million, or other convenient ratios.

Salinization The process of accumulation of salts in soil.

Salt-affected soil Soil that has been adversely modified for the growth of most crop plants by the presence of certain types of exchangeable ions or of soluble salts. It includes soils having an excess of salts, or an excess of exchangeable sodium, or both.

Soil-formation factors The variable, usually interrelated natural agencies that are responsible for the formation of soil. The factors are: parent rock, climate, organisms, relief, and time.

Solonetzic An order of soils developed mainly under grass or grass-forest vegetative cover in semiarid to subhumid climates. The soils have a stained brownish solonetzic B (Bnt or Bn) horizon and a saline C horizon. The surface may be one or more of Ap, Ah, or Ae horizons. The order includes the Solonetz, Solodized Solonetz, and Solod Great groups.

Soil Structure The combination or arrangement of primary soil particles into secondary particles, units, or peds. These peds may be, but usually are not, arranged in the profile in such a manner as to give a distinctive characteristic pattern. The peds are characterized and classified on the basis of size, shape, and degree of distinctness into classes, types, and grades.

Stubble mulch The stubble of crops or crop residues left essentially in place on the land as a surface cover before and during the preparation of the seedbed and at least partly during the growing of succeeding crops. Synonymous with trash cover.

Subsoiling The breaking of compact subsoils, without inverting them, with a special knifelike instrument (chisel), which is pulled through the soil usually at depths of 30 to 60 cm (12 to 24 inches) and spacings of 60 to 150 cm (2 to 5 ft). Also called chiseling.

Summerfallow Cultivated land that is allowed to lie idle during the growing season.

Till To plow and prepare for seeding; to seed or cultivate the soil.

Tillage The operation, practice, or art of tilling land to improve it for agricultural purposes.

Topsoil (i) The layer of soil moved in cultivation. See also surface soil. (ii) The A horizon. (iii) The Ah horizon (iv) Presumably fertile soil material used to topdress roadbanks, gardens, and lawns.

Zone, soil Area in which the dominant or zonal soils reflect the zonal influence of climate and vegetation, and form a natural land pattern with other soils that exhibit the zonal influence only weakly or not at all. The soil zone is not a taxonomic unit, but may be used as a cartographic unit.

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